SUGARBEET RESEARCH

1988 REPORT

FOREWARD

SUGARBEET RESEARCH is an annual compilation of progress reports concerning incomplete research by Agricultural Research Service investigators and cooperators who are engaged in sugarbeet variety and production research. The report has been assembled and reproduced at the expense of the Beet Sugar Development Foundation, and is for the sole use of the cooperators. Much of the data has not been sufficiently confirmed to justify general release and interpretations may be modified with additional experimentation. The report is not intended for publication and should not be used for cited reference nor quoted in publicity or advertising. Reproduction of any portion of the material contained herein will not be permitted without the specific consent of the contributor or contributors.

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Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

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SUGARBEET RESEARCH

1988 Report

Section A

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ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION
1987 AND 1988

BUDDENHAGEN, I. W. and J. E. DUFFUS. Virus diseases of chickpea in California. Phytopathology 78:1538. 1988.

Winter planting of chickpeas in California has revealed their vulnerability to several aphid-transmitted viruses. Virus incidence of 95% with complete yield loss occurred in plots at Davis. Incidence was less in plots in the Central San Joaquin Valley and even less at Salinas. Both high and low incidence were recorded in large commercial plantings. Beet Western Yellows Virus was most frequent at all sites. Two other luteoviruses were also found: Legume Yellows in the Central Valley and Subterranean Clover Red Leaf, at Salinas and Davis. Mechanically transmissible viruses, not yet fully characterized, were also found. Virus transmission began in early March, increasing through April. Only two aphid species colonized the crop, Aphis craccivora, the most abundant, and Acyrthosiphon pisum, rarely. Other aphids found feeding on the crop were Myzus persicae and Hyperomyzus lactucae. Chickpeas, however, were shown to be a poor aphid host; experimental virus transmission proved difficult.

COHEN, S., J. E. DUFFUS, and H. Y. Liu. Acquisition, interference, and retention of cucurbit leaf curl viruses in whiteflies. Phytopathology 79:109-113. 1989.

Squash leaf curl virus (SLCV) antigens could be detected by enzyme-linked immunosorbent assay (ELISA) in Bemisia tabaci extracts when batches of at least 20 females previously fed for 48 hr or more on a SLCV source were tested. ELISA reaction intensity of extracts depended on the age of the squash source plants and the position of the leaves on which B. tabaci fed. ELISA detectable virus antigen and transmission rate were higher with a longer acquisition access period. SLCV antigen detected by ELISA decreased rapidly with time after acquisition feeding, but the insects remained inoculative for many more days. As long as SLCV antigen could be detected in B. tabaci, no significant decrease in transmission efficiency was observed. A reduction in transmission efficiency of melon leaf curl virus (MLCV; closely related to SLCV) by B. tabaci was demonstrated when insects were first allowed to acquire SLCV. A higher SLCV antigen titer per unit weight was found to accumulate in the nonvector whitefly, Trialdurodes abutilonea, than in B. tabaci. These findings are compatible with a model described for luteoviruses, in which the virus in the haemocoele serves as a reservoir for the salivary gland system where virus specific sites exist. It appears, however, that once the SLCV becomes attached to these sites, it remains infectious, but can no longer be detected by ELISA. In the case of T. abutilonea, the inability of the virus to pass through the salivary glands is possibly the reason for its failure to transmit SLCV.

COHEN, S., J. E. DUFFUS, R. PERRY, and R. DAWSON. A collection and marking system suitable for epidemiological studies on whitefly-borne viruses. Plant Disease 73: (In press). 1989.

A simple system designed to monitor the movement and infectivity of whiteflies in epidemiological studies of whitefly-borne viruses is described. A vacuum collector, based on a small cordless rechargeable vacuum cleaner, was modified to collect insects directly into clear plastic sleeve cages. The cages can be used directly as inoculation chambers in the field, as a direct measure of population density, and as a means of monitoring insect movement with tracer florescent dyes. Seedlings inoculated in the collection cages are carried or shipped to the greenhouse and observed for symptoms, eliminating the need for growing bait plants in the field.

DONEY, DEVON L. and E. D. WHITNEY. Beta maritima (see beet) germplasm in England, Wales and Ireland. J. of Sugar Beet Res. 26:A6. 1988. (Abstract)

The collection and evaluation of exotic germplasm has received increased attention in recent years due to the gradual elimination of natural habitats and the need for new stress resistant genes. This is particularly true of Beta maritima (sea beet). This report reviews the 1987 exploration of B. maritima along the sea coast of England, Wales and Ireland. Areas of distribution are compared to previous sitings. Most plants occur in a narrow band between high tide and 10 to 20 meters inland. Plants were most prevalent on shingle (gravel) beaches. In general, the distribution of sitings in 1987 was similar to previously reported distributions. In areas of large populations, no extinction is threatened; however, areas of small populations are threatened and some have already been eliminated. Extinction factors include livestock grazing, particularly sheep, slippage of mud cliffs, industrialization, sea ports, and recreation activities such as cement sea walls, parks and beaches. Other factors such as high tide, wind, animals and man are operating as dispersal agents.

DUFFUS, JAMES E. Soil-borne viruses of the Rhizomania complex. Proc. 5th Internat. Congr. Plant Pathology, Kyoto, Japan, p.452. 1988.

In studies in California and Texas several distinct virus pathogens have been isolated from rhizomania cultures. Some entities have particles which are morphologically similar to beet necrotic yellow vein virus (BNYVV), but differ in host range, symptomology and serological affinities. These BNYVV like viruses are soil-borne and are vectored by Polymyxa betae. Another soil-borne virus from the complex has flexuous filamentous particles c. 12nm in width and 650nm long. This virus causes leaf distortion and mosaic symptoms on sugarbeet. Serological differences between BNYVV cultures from various parts of the world could be accounted for by the presence of serologically unrelated virus entities with morphologically similar virus particles occurring in the same plants.

DUFFUS, J. E., B. W. FALK, and G. R. JOHNSTONE. Luteoviruses -- one system, many variations. A Proceedings of the Workshop, CIMMYT (In press). 1989.

The yellowing and reddening of fields that took place in so many crops throughout the world has long been blamed on natural factors such as aging or nutrient deficiencies. But as difficult as the concept of virtually universal viruses causing nutrient deficiency-like symptoms has been to the agricultural community, the impact of the losses induced by these agents was unmistakable. The viruses that induce stunting of infected plants and patterns of interveinal yellowing, or reddening, that show rolling and brittleness of infected leaves are are transmitted by aphids in a persistent manner, are an interrelated group of viruses termed luteoviruses. Described originally from a number of different crop species from throughout the world as unique and distinct plant viruses, modern technology has shown that the 35 5o 40 distinct entities represent only about nine major distinct serotypes.

Most of the definitive luteoviruses have very narrow and specific host ranges involving one, or perhaps two, plant families. In contrast, beet western yellows virus (BWYV) infects all plant subclasses, orders, and families susceptible to the other luteoviruses. Primeval aphids were polyphagous, and primitive yellowing viruses probably infected a wide range of hosts. Transmission into plant groups with host specific vectors probably gave rise to the monofamily viruses such as barley yellow dwarf. The focus on aphids and specificity of transmission has been important on these yellows diseases because they provide the only means for virus spread in nature and are the key to understanding the ecology of the diseases. Electron microscopy, serology and molecular technology have thus far shown that the luteoviruses are interrelated through their probable origin - BWYV. The ecologically distinct members of the group may or may not be similar to each other but form a continuum of viruses with serological, cytological and epidemiological similarities with BWYV.

The interactions between luteoviruses and related and unrelated viruses in mixed infections may also significantly effect the epidemiology and origin of these viruses. Pea enation mosaic virus appears to have some affinities to the luteoviruses. It may represent an evolutionary link between luteoviruses and mechanically-transmissible small, spherical viruses, or perhaps a link between luteoviruses and the aphid-transmitted helper-dependent virus complexes.

FALK, B. W., L.-S. CHIN, and J. E. DUFFUS. Complementary DNA cloning and hybridization analysis of beet western yellows luteovirus RNAs. Virology (In press). 1989.

Complementary DNAs (cDNAs) to the virion RNAs of the ST9 strain of beet western yellows luteovirus (BWYV) were cloned and used

for hybridization analyses. These showed that the two major virion ssRNAs, the ca. 6 Kb genomic RNA and the 3.1 Kb ST9-associated RNA, do not show detectable sequence homology. Evidence was also obtained that small amounts of a ca. 0.72 Kb ssRNA which hybridized with selected cDNA clones to the BWYV 6 Kb genomic RNA are associated with virions of ST9 and ST9M BWYV isolates. Extracts of plants infected by ST9 and other BWYV isolates contained ssRNAs of ca. 6 Kb, 2.9 Kb and 0.72 Kb. Extracts of ST9-infected plants also contained RNAs of ca. 3.1 Kb and 0.48 Kb which hybridized with selected cDNA clones to the ST9-associated 3.1 Kb virion RNA. cDNA clones of the ST9 virion 6 Kb RNA also hybridized with the genomic 6 Kb RNA of other BWYV isolates. None of the clones hybridized with preparations of other luteoviruses tested. No RNA of sequence related to the ST-9 associated virion 3.1 Kb RNA was detected in virions or plant tissues infected by other isolates of BWYV or luteoviruses.

FALK, BRYCE W. and JAMES E. DUFFUS. Ecology and control. In The Filamentous Plant Viruses, R. G. Milne, Ed., Plenum Press, pp. 275-296. 1988.

Ecology and control of plant viruses should be stressed together, for it is through understanding the ecology and epidemiology of plant viruses and their vectors that we have been able to control successfully a number of important plant virus diseases. It will be seen that some of the ground covered here has been detailed from a different viewpoint in Chapter 7. However, we feel that some overlap is inevitable in putting control measures and their ecological basis in context.

The filamentous viruses mentioned in this chapter encompass four of the major plant virus groups as well as some ungrouped viruses. These are the potyviruses, carlaviruses, closteroviruses (here including capilloviruses), potexviruses, and some ungrouped whitefly-transmitted viruses. Only in the filamentous morphology of their virions are these viruses superficially similar. The physical and biochemical properties differ for each group, and the ecological characteristics of the groups also are diverse. Were an ecological character such as means of dispersal or transmission to be used as the most important taxonomic criterion, these four groups would not have been listed together. There are, however, several successful examples of controlling diseases caused by the viruses in these groups, and the approach to their control has in many cases been similar in theory.

Viruses must "move" or have a means for dispersal to ensure survival, and they have adopted a variety of means to accomplish this. Generally, within a given group the primary means of spread is shared by other members of the group (e.g., potyviruses and nonpersistent transmission by aphids). Nevertheless, viruses within a given group may have several diverse types of ecology, or disease cycle. A classical method for controlling any disease is to identify the disease cycle and

then to exploit the weakest or most vulnerable link. This approach has been successful for some filamentous plant viruses; when control of this type has been implemented, it has generally been very effective and permanent.

GERIK, J. S. and J. E. DUFFUS. Host range of California isolates of Polymyxa betae. Phytopathology 77:1759. 1987.

The host range of five isolates of Polymyxa betae Keskin were investigated. The isolates included three from Beta vulgaris L. (sugarbeet), one from Amaranthus spinosus L. (spiny amaranth) and one from Portulaca oleracea L. (purslane). The tested plants included 24 common crop and weed species in 10 families. The isolates from sugarbeet were found to infect species in the Chenopodiaceae and Amaranthaceae. In addition to their original host, the isolates from A. spinosus and P. oleracea were found to infect sugarbeet 'US H11'. Previously, isolates from these species from Japan were reported not to infect sugarbeet (Ann. Phytopath. Soc. Japan 52:235-247). The data indicate, for the first time, weed species outside the Chenopodiaceae may increase inoculum of P. betae in the absence of sugarbeet.

GERIK, J. S. and J. E. DUFFUS. Spatial occurrence of Polymyxa betae and beet necrotic yellow vein virus in California sugarbeet fields. Proc. 5th Internat. Congr. Plant Pathology, Kyoto, Japan, p. 452. 1988.

The spatial occurrence of Polymyxa betae and beet necrotic yellow vein virus (BNYVV) in sugarbeet fields located in the San Joaquin Valley of California was investigated. Fields thought to be recently infested were chosen for the study. Soil samples were collected from 0.4 hectare sectors using a stratified random sampling method. Seed of sugarbeet was planted in these soil samples and the occurrence of P. betae was determined microscopically and that of BNYVV serologically. The occurrence of P. betae was uniform in most fields. The occurrence of BNYVV was variable; some fields were totally infested, others were only slightly infested. One field in which no known symptoms of rhizomania on beets had ever occurred was infested with BNYVV, indicating the possible association of weed host with the increase of this virus. Clustered sectors, not infested with P. betae, were observed in some fields. The patterns of the non-infested sectors were indicative of soil differences between the infested and non-infested areas. Rhizoplane microflora were found to differ between these areas.

GERIK, J. S. and J. E. DUFFUS. Differences in vectoring ability and aggressiveness of isolates of Polymyxa betae. Phytopathology 78:1340-1343. 1988.

Six nonviruliferous isolates of Polymyxa betae from California, Colorado, Nebraska, and Alberta, Canada, were tested for their ability to acquire and transmit beet necrotic yellow vein virus (BNYVV) and cause damage to sugarbeet plants. All of the isolates tested transmitted BNYVV from systemically infected

Beta macrocarpa to sugarbeet. Infection by viruliferous isolates of P. betae resulted in decreased root weight and increased root branching and root tip mortality when compared with noninfected controls. Nonviruliferous isolates of the fungus decreased the top weight and root weight of sugarbeet when compared to controls. Differences in the amount of damage caused by BNYVV were observed when the virus was transmitted by individual isolates. An isolate from the Sacramento Valley was found to be more aggressive than other isolates.

GERIK, J. S., R. T. LEWELLEN, and J. E. DUFFUS. Resistance to Polymyxa betae in sugarbeet varieties with differential reactions to Rhizomania. Phytopathology 77:1759. 1987.

Rhizomania of sugarbeet is caused by beet necrotic yellow vein virus which is transmitted by Polymyxa betae. Five sugarbeet varieties exhibited a differential response to infection by a non-viruliferous isolate of P. betae. The greenhouse test included varieties susceptible, resistant, and tolerant to rhizomania. Measurements were made on inoculated and non-inoculated plants to determine the amount of damage caused by P. betae. Significant interactions between the two factors (variety and P. betae inoculation) were observed for several variables, including infection of P. betae, top weight, root weight, and number of healthy root tips. The data suggest that rhizomania resistant and tolerant sugarbeet varieties are resistant to P. betae when compared to a rhizomania susceptible variety.

GERIK, J. S. and J. E. DUFFUS. Spatial occurrence of Polymyxa betae and beet necrotic yellow vein virus in California sugarbeet fields. J. Sugar Beet Res. 26:A8. 1989.

The spatial occurrence of beet necrotic yellow vein virus (BNYVV) and Polymyxa betae in sugarbeet fields located in the San Joaquin Valley and Imperial Valley of California was investigated. Fields thought to be recently infested were chosen for the study. Soil samples were collected from one acre sectors using a stratified random sampling method. Seeds of sugarbeet were planted in these soil samples and grown for 8 weeks. The occurrence of BNYVV in roots of seedlings was determined by ELISA and that of P. betae microscopically. Ordinary runs analyses were performed on the data to determine if the distributions were clustered either down or across the rows. The occurrence of BNYVV was variable; some fields were totally infested; others were only slightly infested. Clustered patterns were more frequent down rather than across the rows indicating movement of the virus with irrigation water. One field in which no known symptoms of rhizomania on beets had ever occurred was totally infested with BNYVV, indicating the possible association of weed host with the increase of this virus. The occurrence of P. betae was uniform in most fields, even when BNYVV was clustered. This observation indicates that an introduced viruliferous population of P. betae can displace the endogenous nonviruliferous population. Clustered sectors,

not infested with P. betae, were observed in some fields. The patterns of the non-infested sectors were indicative of soil differences between the infested and non-infested areas. Rhizoplane microflora were found to differ between these areas.

HOEFERT, LYNN L. Association of squash leaf curl virus with nuclei of squash vascular cells. Phytopathology 77:1596-1600. 1987.

Squash leaf curl is a whitefly-transmitted virus disease affecting members of the Cucurbitaceae and is caused by a geminivirus. It is associated with nuclei of vascular tissues in leaves of zucchini squash and with maturing phloem sieve elements. Whiteflies probe leaves mainly from the abaxial surface, and internal symptoms are expressed to a large extent in the vascular tissue of the abaxial phloem. Severe necrosis of sieve elements occurs after only 9 days of infection. The disease is discussed in comparison to other whitefly-transmitted geminivirus diseases of plants.

HOEFERT, LYNN L. Comparative cellular effects of Lettuce Infectious Yellows Virus in leaves of several hosts. Amer. J. Bot. 75:57. 1988. (Abstract)

The ultrastructural effects of Lettuce Infectious Yellows Virus were compared in the vascular tissues of leaves of viral hosts from five different plant families (Asteraceae, Brassicaceae, Chenopodiaceae, Cucurbitaceae, and Malvaceae). Inclusions composed of virions as well as virus vesicles and regions of viroplasm were contrasted and compared in the various host cells. Both light and electron microscopy were used to characterize the inclusions. For light microscopy, root squashes, epidermal peels and hand sections of leaf veins were stained for virus inclusions using Christie's method with Orange-Green and Azure A stains. Comparisons between light and electron micrographs of vascular tissue from whitefly-inoculated plants were made.

HOEFERT, LYNN L., GAIL L. FAIL, and ROBIN L. PINTO. Structural comparison of C_4 bundle sheath cells with and without a virus. Amer. Phytopath. Soc., Abstracts of Presentations #409. 1988.

A plant often used for virus host-range studies is Gomphrena globosa L., a member of the family Amaranthaceae. It is a dicotyledonous member of the C_4 group of plants and exhibits the typical "Kranz" anatomy of bundle sheath cells surrounding the vascular bundles of the leaf. Structural comparisons by light and electron microscopy were made of the bundle sheath cells from healthy G. globosa leaves and from those infected with beet distortion mosaic virus, a recently described sugarbeet virus mechanically transmitted to G. globosa. Associations between the virus and chloroplasts of the bundle sheath cells were observed. The significance of the virus presence in cells specialized for nutrient transfer will be discussed.

HOEFERT, LYNN L., ROBIN L. PINTO, and GAIL L. FAIL. Ultrastructural effects of Lettuce Infectious Yellows Virus in Lactuca sativa L. J. Ultrastructure and Molecular Structure Res. 98:243-253. 1988.

Lettuce Infectious Yellows Virus (LIYV) is a whitefly-transmitted virus with characteristics similar to the Closterovirus group. We describe an ultrastructural study of the development of LIYV disease in young lettuce (Lactuca sativa) leaves at 5, 12, 14, and 35 days after inoculation. LIYV particles are long, flexuous rods found initially in leaf vascular parenchyma cells and sieve elements. The development of virions in the parenchyma cell is preceded by the appearance of vesicles. These vesicles contain fine fibrils and occur in tightly packed arrays. At later stages after inoculation, virions appear in spherical sites, termed "viroplasm" regions, in the cell cytoplasm. Finally, the virions become aggregated into inclusion bodies which often comprise a major volume of the parenchyma cytoplasm. Electron-dense deposits of material of unknown composition are associated with the infection and appear along the plasma membrane.

JENSEN, CONNIE S., J. S. GERIK, and J. E. DUFFUS. Avoiding rhizomania by testing soil for BNYVV. J. Sugar Beet Res. 26:A12. 1989.

Rhizomania continues to spread among sugarbeet fields in California. More than 75,000 acres of farm land in California are now known to be infested with rhizomania. In 1988 the pathogens were detected for the first time in soil from the Imperial Valley. One of the best methods of rhizomania control has been avoidance of the disease through soil tests. During the last 4 years growers' soil samples have been assayed for beet necrotic yellow vein virus (BNYVV). BNYVV is detected in the samples with a bioassay. Beet seed is planted in the soil samples and allowed to grow for 8 weeks, in which time they may become infected with BNYVV. The virus is detected in the root tissue by ELISA. During the years 1986-1988, 4,284 soil and tissue samples, representing 1435 fields and 102,800 acres have been assayed; 40% of these samples representing over 43,000 acres were positive for BNYVV, while 75% of these samples were positive for the vector, Polymyxa betae. By avoiding infested fields growers are able to reduce yield losses due to rhizomania. Yield data from 1986 indicate disease losses were reduced by 25%, or by an average of 1.5 tons of sugar per acre. This translates to more than a $600 per acre additional gross value compared to diseased fields. The assay produced false positive results at a rate of 12% and 0 - 18% false negative results. New testing procedures have been implemented to minimize the false results.

JOHNSTONE, G. R., J. E. DUFFUS, and P. L. GUY. Records on the occurrence of beet western yellows virus in Australia, New Zealand and Mexico. Australian J. Agric. Res. (In press). 1989.

An isolate of beet western yellows virus (BWYV) from lettuce in

Tasmania was propagated in shepherd's purse, purified, and used to produce an antiserum in a rabbit. The lettuce isolate and the antiserum to it reacted similarly to the Californian type isolate from radish and its antiserum in double antibody sandwich enzyme-linked immunosorbent assays (DAS-ELISA). The Tasmanian DAS-ELISA system was used to confirm the presence of BWYV in a range of plant species from the southern mainland states of Australia, from the North Island of New Zealand and from central Mexico. Leaf tissue containing BWYV remained serologically reactive for long periods after the tissue was desiccated either by freeze-drying or drying over silica gel. Bean leaf roll, potato leaf roll and soybean dwarf viruses were clearly distinct from BWYV and from each other in DAS-ELISA.

KIRKPATRICK, BRUCE C., DRAKE C. STENGER, T. JACK MORRIS, and ALEXANDER H. PURCELL. Cloning and detection of DNA from a nonculturable plant pathogenic mycoplasma-like organism. Science 238:197-200. 1987.

The ability to detect, quantify, and differentiate nonculturable mycoplasma-like organisms (MLOs) would greatly facilitate epidemiological and taxonomical studies of this unique group of plant and insect pathogens. DNA isolated from extracts of insects infected with the Western X-disease MLO was cloned in Escherichia coli. X-disease-specific clones, when labeled and used as probes, readily detected X-disease MLOs in infected plants and insects but did not hybridize with DNA from healthy plants or insects, or from several other plant pathogenic MLOs or spiroplasmas. These methods provide both a sensitive diagnostic tool and a basis for genetically differentiating MLOs.

LARSEN, R. C., H-Y. LIU, B. W. FALK, and J. E. DUFFUS. Characterization of lettuce infectious yellows virus. Phytopathology 88:1561. 1988.

Virions of lettuce infectious yellows virus (LIYV), a whitefly-transmitted clostero-like virus, were purified from infected N. clevelandii and characterized. A single major protein of 32,000 MW was detected by SDS-PAGE. This protein specifically reacted with antiserum to LIYV nucleoproteins in immunoblots. Immunoblot analysis of total protein extracts of LIYV-infected plants also gave reactions only to a 32,000 MW protein. Necleic acid extracted from purified LIYV virions revealed a single major species of ss-RNA of ca. 7000 bases. Ds-RNA analysis of LIYV-infected plants showed multiple bands with a major band of ca. 5 million molecular weight.

LEWELLEN, R. T., I. O. SKOYEN, and A. W. ERICHSEN. Breeding sugarbeet for resistance to rhizomania: Evaluation of host-plant reactions and selection for and the inheritance of resistance. Abstracts, 50th Winter Congress, I.I.R.B., Brussels, Belgium, Feb. 11-12, 1987, p. 105.

Rhizomania caused by beet necrotic yellow vein virus (BNYVV) vectored by the soil-borne fungus Polymyxa betae Keskin was

first identified in sugarbeet in North America in 1983. Subsequently, it has been found throughout California. Because of the severe yield loss potential, an immediate need was recognized for rhizomania resistant varieties with adaptation to Western USA. A research program was initiated in 1984 at Salinas. The goals of the resistance breeding program were initially to gain experience with this disease, to compare performance of hybrids grown under rhizomania conditions with their performance under similar conditions in Europe, to confirm reported sources of resistance and identify new sources of genetic variability for host-plant reactions, and to develop an efficient and critical evaluation and selection program. Longer range goals were to develop highly resistant germplasm, to characterize and determine commonalty of different sources of resistance, and to study the inheritance and mechanisms of resistance. This paper summarizes the interim results of these studies from 1984 through 1986.

LEWELLEN, R. T. and I. O. SKOYEN. Registration of 17 monogerm, self-fertile germplasm lines of sugarbeet derived from three random-mating populations. Crop Sci. 27:371-372. 1987.

Seventeen monogerm breeding lines have been released between 1981 and 1985 from the USDA-ARS sugarbeet germplasm improvement and breeding methodology program at Salinas, CA. This lines were developed by the USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association and were jointly released. These breeding lines are increases of selected progenies from three monogerm, self-fertile (S^f), genetic male-sterile facilitated, random-mating populations developed at Salinas by four selection methods. Some possess combinations of traits that make them potentially useful as parental lines in commercial hybrids, e.g., C301, C306, C790-55, C790-55, C790-69 and C796-22. However, these lines were primarily released as advanced sources for establishing new or improved monogerm, random-mating populations that combine genetic variability for high general combining ability for sugar yield, adaptation to the far western USA, nonbolting tendency, and multiple disease resistance.

LEWELLEN, R. T. and I. O. SKOYEN. Registration of C309 and C309CMS sugarbeet parental lines. Crop Sci. 28:581. 1988.

C309 and C309CMS sugarbeet were developed by USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association. C309 and C309CMS were jointly released in 1985. C309 (Reg. no. PL-25) is a diploid (2n=18), self-fertile (S^f), monogerm line. It is mixed for red and green hypocotyl color and segregates for genetic male sterility (a_1a_1). It is an O-type (nonrestorer) but requires a cytoplasmic male sterile with good emasculating efficacy to assure that its F_1CMS hybrids are completely sterilized. It is a moderately nonbolting type, but in overwintered productions it flowers early and is somewhat difficult to match with late flowering lines.

LEWELLEN, R. T. and I. O. SKOYEN. Registration of four monogerm, self-fertile, random-mated sugarbeet germplasms. Crop Sci. 28:873-874. 1988.

The USDA-ARS in cooperation with the Beet Sugar Development Foundation and the California Beet Growers Association released four random-mated populations of sugarbeet (Beta vulgaris L.) between 1977 and 1986. Plants in these populations are self-fertile (S^f), and random mating is facilitated by the segregation of genetic male sterility (a_1a_1). The populations are genotypically monogerm ($\overline{mm}$), although the quality of this trait remains varied. The diversity and structure of these populations should provide useful germplasm to public and private breeding programs for both parental line development and continued population improvement. Specific lines extracted from these populations have been released, and several of these are being used as parental lines in commercial hybrids. At the time of their release, a cytoplasmic male sterile version of each of these populations was made available.

LEWELLEN, R. T. Registration of cytoplasmic male-sterile sugarbeet germplasm C600CMS. Crop Sci. 19:246. 1989.

Sugarbeet germplasm C600CMS, released in 1988, is the cytoplasmic male-sterile equivalent of C5600 released in 1965. Also known as C600, C5600 is an annual (BB), homozygous (autodiploid) line that is closely related to NB1. Genotypically, C5600 and C600CMS are BB, rr, MM, and S^fS^f and have excellent O-type characteristics. They are resistant to the curly top virus and are bolting resistant annuals; i.e., in the absence of vernalization, C5600 and C600CMS require an exceptionally long period of exposure to long-day conditions to initiate seed stalks. C5600 has already proven useful in genetic studies of sugarbeet. However, because of its highly self-fertile nature, F_1 hybrids have been difficult to produce. The male sterility of C600CMS should enhance the value of this germplasm in future genetic and plant breeding programs. Recently, it has been shown (R. T. Lewellen, unpublished) that the combination of high nonbolting tendency and male sterility in this annual also may make it useful as a tester to discriminate and sort biennial (bb) genotypes for bolting tendency in short season greenhouse or field tests under warm, long-day conditions.

LEWELLEN, R. T. Selection for resistance to rhizomania in sugarbeet. Abstracts of 5th Internat. Congr. Plant Pathology, Kyoto, Japan, p. 455. 1988.

Genetic variability for reaction to rhizomania was identified in diverse Beta germplasm, including sugarbeet, B. vulgaris L. To determine the response to selection for resistance, progress within representative sources was measured. Sources included types of variability that fit patterns for either qualitative or quantitative inheritance. Selections and evaluations were made and compared under both intermediate (June-Nov.) and short

(July-Dec.) seasons in field plots with high disease pressure. Root symptomology and yield were used as the criteria of selection and evaluation. Backcross and F_3 analyses confirmed that the Holly source of resistance was inherited as a single dominant allele and was named Rz. Rz conditions high resistance but not immunity. From quantitatively inherited sources, progress was made in each cycle of selection After three cycles of phenotypic recurrent selection, synthetics derived from diverse sources (C39, Y47, FC-Rhizoc., etc.) had reached the level of protection provided by the Rz allele. However, unlike Rz, hybrids between these synthetics and susceptible parents had mid-parental values for resistance. Empirical evidence showed that reaction to rhizomania is highly heritable and that field tests and selections based upon symptomology/yield were sufficiently critical.

LEWELLEN, R. T. and I. O. SKOYEN. Development of rhizomania resistant sugarbeet germplasm. J. Sugar Beet Res. 26:A14. 1989.

Genetic variability for reaction to rhizomania has been identified in diverse Beta germplasm. Response to selection for resistance was measured within representative sources. Sources included types of variability that fit patterns for either qualitative or quantitative inheritance. Selections and evaluations were made and compared in field plots with high disease pressure at Salinas. Root symptomology and yield were used as the criteria of selection and evaluation. Four cycles of selection have been completed and evaluated within putatively quantitatively inherited sources. Progress was made in each cycle of selection. After three cycles of phenotypic recurrent selection, synthetics derived from diverse sources (C39, Y47, FC-Rhizoc., etc.) had reached the level of protection provided by the Rz allele. However, unlike Rz, hybrids between these synthetics and susceptible parents had mid-parental values for resistance. Empirical evidence showed that reaction to rhizomania is highly heritable and that field tests and selections based upon symptomology/yield wee sufficiently critical for discriminating differential disease reactions. Near-isogenic lines differentiated by Rz were significantly different for resistance and yield when tested under rhizomania conditions. Although root traits were confounded by their B. maritima sources of resistance, resistance to rhizomania has been transferred from B. maritima to sugarbeet. High resistance was identified in one plant from accession PI206407 (Turkey vulgaris type) and appears to be inherited in a dominant manner.

LEWELLEN, R. T. and I. O. SKOYEN. S_1 progeny recurrent selection to improve yield of sugarbeet. J. Sugar Beet Res. 26:A14. 1989.

Recurrent selection may be useful to increase the frequency of favorable alleles for yield. Four cycles of S_1 progeny recurrent selection have been completed in sugarbeet population-790. Sugar yield was used as the criterion of

selection. Performance of synthetics from each cycle were compared in field tests. Compared to the unimproved population (C0), the C4 synthetic was improved by 30, 22, and 7% for gross sugar yield, root yield, and sucrose concentration, respectively. Most improvement for root yield and gross sugar yield was from C1 and C4, whereas most improvement for sucrose concentration was from C2. Thus, S_1 progeny recurrent selection discriminated S_0 genotypes for yield and was an effective method of population improvement in sugarbeet. However, the rate of progress per year (3 years/cycle) and rigid design may not justify such a long term program when populations need improvement for many factors (genetic structure, resistance to diseases, pests, and stresses, etc.) in addition to components of yield. Based on experimental results, a population improvement program will be outlined that has greater flexibility and reduced intervals per cycle of selection but still encompasses the efficacy of S_1 and S_2 progeny evaluation as pivotal steps to isolate and discriminate superior genotypes.

LEWELLEN, R. T. and I. O. SKOYEN. Screening sugarbeet genotypes for nonbolting tendency using an annual tester. J. Sugar Beet Res. 26:A15. 1989.

The most common procedure to evaluate genotypes of sugarbeet for resistance to bolting is exposure to extended periods of cold induction followed by long day conditions in overwintered or winter plantings in the field. This method is effective but subject to extremes in environmental conditions, costly in time, and may be inconvenient. A procedure to evaluate genotypes for bolting under more closely controlled conditions and within a shorter period would have advantages. A procedure involving an annual tester to evaluate biennial genotypes is being investigated. When an easy bolting annual was used as a common tester, all F_1 hybrids bolted quickly and synchronously under long day conditions in the field or greenhouse. However, when a nonbolting (hard bolting) annual tester was crossed to biennial plants, the F_1 testcrosses bolted over an extended period. The association between the known bolting tendency of biennials and that of their annual testcrosses was high. Also, a high association occurred between the rate or timing of bolting in tests under lighted greenhouse and spring planted field tests without cold induction. Preliminary evidence suggests that specific biennial genotypes can be categorized and sorted for their bolting tendency with the aid of a hard bolting annual tester. Line C600CMS was released in 1988 for this purpose.

LIU, H. Y., J. E. DUFFUS, and J. S. GERIK. Beet distortion mosaic virus--A new soil-borne virus of sugarbeet. Phytopathology 77:1732. 1987.

A new soil-borne virus which causes leaf distortion and mosaic symptoms on sugarbeet has recently been found from sugarbeet in Texas. The infectious agent, termed beet distortion mosaic virus (BDMV), is mechanically transmissible. In limited host

range studies, it mechanically affects Beta vulgaris, B. macrocarpa, Spinacia oleracea and some chenopodiaceous weed hosts. The virus particles are long flexuous rods c. 12 nm in width and 200-2400 nm in length. The particles are similar in size to those of wheat spindle streak mosaic virus (WSSMV). In preliminary tests, however, pinwheel inclusion bodies have not been found in sugarbeet tissue infected with BDMV and no serological relationship to WSSMV has been demonstrated. The virus is soil borne and some evidence indicates that the vector is the fungus Polymyxa betae Keskin.

LIU, HSING-YEH, and JAMES E. DUFFUS. New soil-borne viruses of sugarbeet. J. Sugar Beet Res. 26:A15. 1989.

In studies in California and Texas three distinct viral pathogens similar in particle morphology to beet necrotic yellow vein virus (BNYVV), the causal agent of rhizomania of sugarbeet, have been isolated from rhizomania infested fields. These BNYVV-like viruses are mechanically transmissible and vectored by the soil fungus Polymyxa betae Keskin. However, these isolates are distinct from BNYVV in symptom expression, host range, and serology. Because these viruses have particles similar to those of BNYVV there is confusion in electron microscopic based routine tests for BNYVV. Therefore, host range and serological tests also should be used. The distribution of these viruses in the field, their economic importance, and the relationship of these entities to the rhizomania disease of sugarbeet are not yet known.

LIU, HSING-YEH and JAMES E. DUFFUS. The occurrence of a complex of viruses associated with rhizomania of sugarbeet. Phytopathology 78:1583. 1988.

Three distinct viral pathogens similar in particle morphology to beet necrotic yellow vein virus (BNYVV), the causal agent of rhizomania of sugarbeet, have been isolated from rhizomania infested fields in California and Texas. These BNYVV-like viruses are vectored by Polymyxa betae Keskin. However, these isolates are distinct from BNYVV in symptom expression, host range, and serology. The distribution of these viruses in the field, their economic importance, and the relationship of these entities to the rhizomania disease of sugarbeet are not yet known.

McLAUGHLIN, M. R., V. D. DAMSTEEGT, J. E. DUFFUS, and A. D. HEWINGS. Subterranean clover red leaf (soybean dwarf)-like luteovirus found in Mississippi. Phytopathology 78:1584. 1988.

In April 1987, subterranean clover plants, Trifolium subterraneum cv. Meteora, with red leaf margins were collected in the field at Mississippi State, MS. Sap extracts of these plants reacted positively in ELISA with antisera to a Japanese isolate of soybean dwarf virus (SDV) and a California isolate of subterranean clover red leaf virus (SCRLV). The Mississippi isolates were transmitted persistently by Acyrthosiphon pisum,

but not by Aulacorthum solani or mechanical inoculation. The isolates induced red leaf symptoms in indicator hosts, T. subterraneum cvs. Geraldton and Mt. Barker. The serology, transmission, and host symptoms, of these isolates appear similar to SCRLV strains of SDV.

PINTO, ROBIN L., LYNN L. HOEFERT, and GAIL L. FAIL. Development of infection with Lettuce Infectious Yellows Virus in Lactuca sativa L. Amer. J. Bot. 75:58. 1988. (Abstract)

We describe the ultrastructural effects of the development of Lettuce Infectious Yellows disease in Summer Bibb lettuce. Leaves of various ages were inoculated with LIYV via the whitefly vector and collected at intervals after inoculation. The virions are long flexuous rods similar in morphology to C1Lactuca sativaLactuca sativaosteroviruses. Primary symptoms of the disease are found in vascular parenchyma cells. Virus vesicles and electron-dense deposits on the plasmalemmae appear as the first symptoms of the virus infection. Regions of viroplasm, inclusion bodies composed of virus particles and hypertrophied mitochondria are evident at more advanced stages of the disease.

SHEPHERD, R. J., R. D. RICHINS, J. E. DUFFUS, and M. K. HANDLEY. Figwort mosaic virus: Properties of the virus and its adaption to a new host. Phytopathology 77:1668-1673. 1987.

Properties and characterization of figwort mosaic (FMV), a caulimovirus, are described. The virus infects plants of the Scrophulariaceae, Chenopodiaceae, and Solanaceae, usually inducing chlorotic mottling symptoms. It is transmissible both mechanically and by aphids. Infected leaves contain amorphous inclusion bodies with an electron dense matrix in which isometric particles of about 50 nm are embedded. FMV is very distantly related serologically to cauliflower mosaic virus (CaMV). It has a slightly smaller sized DNA genome (about 7,750 base pairs vs. 8,031 for CaMV DNA), which exhibits the same conformational forms during gel electrophoresis as CaMV DNA. FMV DNA contains four single-stranded discontinuation in CaMV DNA. The discontinuation were mapped in relation to various restriction endonuclease cleavage sites. The physical map of the genome is distinctly different from that for any other caulimovirus. Virus maintained in Datura innoxia for a 2-yr period produced different symptoms on D. stramonium and reached a concentration in the latter nearly 10-fold higher than the original isolate from figwort. Nucleotide changes occurred in the gene VI portion of the genome of FMV. The gene VI sequence of FMV apparently mutates rapidly during adaptation of the virus to a new host.

SKOYEN, I. O., R. T. LEWELLEN, and E. D. WHITNEY. Comparison of resistance to rhizomania from diverse sources. J. Sugar Beet Res. 26:A22. 1989.

Sources of resistance or tolerance to rhizomania have been independently identified. It is unknown how much protection

against rhizomania these sources provide and their relative magnitude of control. Tests were grown at Salinas under various combinations of infested and noninfested and fumigated and nonfumigated treatments to measure differential damage to rhizomania. Varieties used were 'US H11' (susceptible check), 'Rhizosen' (Holly hybrid that segregates for the gene Rz), 'Rizor-3' (SES variety from Europe), and R39 (source of C39/R4). Under nondiseased conditions, the relative sugar yield for these four varieties was 100, 112, 106, and 98%, where as under severe rhizomania, the sugar yield was 100, 370, 400, and 440%, respectively. The results suggested that resistance from the three sources was nearly equal but did not provide complete protection. Under severe rhizomania conditions, all roots of Rhizosen, Rizor-3, and R39 showed damage and nonfumigated plot yields were 20-30 percent lower than fumigated plot yields. Some of the yield reduction may be due to other causes as a result of 4-6 years of continuous sugarbeet culture.

SMITH, G. A., M. O. BAGBY, R. T. LEWELLEN, D. L. DONEY, P. H. MOORE, F. J. HILLS, L. G. CAMPBELL, G. J. HOGABOAM, G. E. COE, and K. FREEMAN. Evaluation of sweet sorghum for fermentable sugar production potential. Crop Sci. 27:788. 1987.

This study was prompted by the special interest in sugar crops, at a time of high petroleum prices and fuel shortages, as potential renewable resources which would supplement non-renewable fossil resources. Four to six sweet sorghum [Sorghum bicolor (L.) Moench] cultivars were evaluated 4 yr for fermentable sugar production potential at eight locations in the continental USA and at one location in Hawaii. Latitudes represented ranged from 21 to 47° N with the average number of frost-free days ranging from 120 to more than 350. Data were collected for biomass yield, percent lignin, percent cellulose, stalk sugar yields, and other agronomic characters. Total sugar yield for the continental USA ranged from 4 Mg ha^{-1} to 10.7 MG ha^{-1} during 3 yr of the study and up to 12 Mg ha^{-1} at the Hawaiian location. Accordingly, theoretical ethanol production in the continental USA ranged from 2129 L ha^{-1} to 5696 L ha^{-1}. Results of the study demonstrated that sweet sorghum is far more widely adapted than was anticipated for a plant of tropical origin and certainly has the potential for providing a good source of fermentable carbohydrates across a wide geographic area.

STENGER, DRAKE C., RUTH H. MULLIN, and T. JACK MORRIS. Characterization and detection of the strawberry necrotic shock isolate of tobacco streak virus. Phytopathology 77:1330-1337. 1987.

An isolate of tobacco streak virus (TSV) was recovered from Fragaria vesca displaying typical symptoms of necrotic shock (NS). Host reactions, serological relationships, and RNA sequence homologies were compared among TSV-NS and isolates from blackberry (R), bean (RN), tobacco (M), and white clover (WC). The five isolates could be distinguished from each other by the

responses of three experimental host species. Serological and Northern hybridization tests established two distantly related subgroups comprised of isolates NS and R in one group and WC, M, and RN in the other. Recombinant plasmids containing complementary DNA sequences derived from TSV-NS RNA 3 were used to ascertain the suitability of dot hybridization tests for detection of TSV-NS infection in Fragaria spp. Cloned DNA sequences were labeled with ^{32}P by nick translation and hybridized to nucleic acid extracts spotted onto nitrocellulose. The dot hybridization assay readily detected TSV-NS in extracts representing both acute and chronic infections of Fragaria spp., and the sensitivity of the assay was equivalent to that of double antibody sandwich enzyme-linked immunosorbent assay.

STENGER, D. C., R. H. MULLIN, and T. J. MORRIS. Isolation, molecular cloning, and detection of strawberry vein banding virus DNA. Phytopathology 78:154-159. 1988.

DNA with caulimovirus properties was isolated from strawberry vein banding virus (SVBV). Native viral DNA of 7.8 kbp was circular and double-stranded. Each DNA strand contained one discontinuity positioned at either 0.0 or 0.5 map units on the circular molecule. EcoRI-digested SVBV DNA was cloned into the Escherichia coli plasmid pUC8. A recombinant plasmid (pSVBV-E3) containing a 7.8 kbp EcoRI insert hybridized to SVBV DNA but not to cauliflower mosaic virus DNA and had a restriction map identical to that of SVBV DNA. Dot hybridization tests using pSVBV-E3 as a probe indicated SVBV DNA titer varied greatly between leaflets sampled from the same plant.

STENGER, D. C., J. RICHARDSON, E. S. SYLVESTER, A. O. JACKSON, and T. J. MORRIS. Analysis of sowthistle yellow vein virus-specific RNAs in infected hosts. Phytopathology 78:1473-1477. 1988.

Recombinant plasmids containing sequences derived from the genome of sowthistle yellow vein virus (SYVV) were constructed and used as probes in northern blots to analyze viral-specific RNAs extracted from infected plants and aphids. Recombinant plasmid probes hybridized to a 13-kb, genome-size RNA present in extracts from infected but not uninfected hosts. Four distinct size classes of polyadenylated RNAs were also detected in infected plant extracts. No sequence relatedness was detected between the genomic RNAs of SYVV and another plant rhabdovirus, Sonchus yellow net virus (SYNV), in northern blots by using plasmids containing SYVV or SYNV sequences, or DNA complimentary to SYNV RNA as probes. SYVV plasmid probes detected SYVV infection of individual aphids in dot-hybridization assays.

SYLVESTER, E. S., J. RICHARDSON, and D. C. STENGER. Use of injected Macrosiphum euphorbiae aphids as surrogate vectors for transfer of strawberry crinkle virus to Nicotiana species. Plant Disease 71:972-975. 1987.

The polyphagous pink and green potato aphid (Macrosiphum

euphorbiae) did not acquire strawberry crinkle virus (SCV) from Alpine strawberry (Fragaria vesca) by feeding. When infected with SCV by injection, it transmitted the virus to Alpine test seedlings and to Nicotiana glutinosa and N. clevelandii. Both Nicotiana species, when infected, developed symptoms, and rhabdoviruslike particles were found in negatively stained leaf-dip preparations examined in the electron microscope. An extract from symptomatic leaves of N. glutinosa was used to inoculate healthy M. euphorbiae, and 5% of the injected aphids transmitted virus to Alpine test seedlings. An electron microscopic examination of a negatively stained preparation of a symptomatic flower petal from one of the infected Alpine seedlings contained rhabdoviruslike particles. Furthermore, Chaetosiphon fragaefolii reared on this plant subsequently transmitted SCV to other test seedlings. Attempts to mechanically transmit the virus from the two susceptible Nicotiana species failed. Comparative data indicated that M. euphorbiae was a somewhat less competent vector than C. fragaefolii when transmitting SCV to Alpine strawberry test seedlings.

TEMPLE, STEVEN R., MARK KIRK, and ROBERT LEWELLEN. Field inoculation and screening of sugarbeet varieties and experimental lines for resistance to beet yellows virus. J. Sugar Beet Res. 26:A25. 1989.

The past four California sugarbeet crops have suffered substantial losses caused by infection with beet yellows virus, in spite of emphasis on disease-free programs established by the industry since 1965. Serological testing for BYV has been employed to 1) update our knowledge of BYV epidemiology, and 2) improve the efficiency of artificially inoculating varieties and experimental lines with BYV in an effort to improve levels of genetic resistance. Forty-seven hybrid varieties and 100 half sib families were planted at Davis in a replicated, split plot experiment in which paired rows represented inoculated and noninoculated treatments. Green peach aphids were reared under controlled conditions on plants inoculated and serologically validated for systemic BYV infection, then "harvested" for inoculating five-week old seedlings in the field in early June. ELISA results indicated an efficiency of 80-100% BYV infection among inoculated rows, and 27-40% in the noninoculated rows. Harvest data for sugar yield showed very highly significant differences among varieties and between the inoculated and noninoculated treatments. Results are being used by the California Seed Evaluation Committee to identify and recommend more resistant hybrids for growers in chronic BYV areas, and by sugarbeet breeders to further improve levels of genetic resistance in future varieties.

THEURER, J. C., D. L. DONEY, G. A. SMITH, R. T. LEWELLEN, G. J. HOGABOAM, W. M. BUGBEE, and J. J. GALLIAN. Potential ethanol production from sugar beet and fodder beet. Crop Sci. 27:1034-1040. 1987.

Fodder beet and sugar beet (Beta vulgaris L.) cultivars were

evaluated in field trials at six locations to assess the potential ethanol fuel production from beet crops in the USA. This research was stimulated by the potential world petroleum fuel shortages in the 1970s and a need to assay the merit of sugar and starch crops for potential alcohol fuel production. Fodder beet cultivars had greater root weight and less sucrose content than sugar beet. Fodder beets contained more glucose and fructose than sugar beet but these sugars amounted to <1% of the total sugar content. Average potential ethanol production for all locations was 5.34 and 6.38 kL ha^{-1} in 1980 and 1081, respectively, for fodder beet, compared to 5.36 and 6.68 kL ha^{-1} for sugar beet cultivars. Salinas, CA, with a long growing season, had a potential alcohol yield from beets of 8.64 kL ha^{-1}, while potential ethanol yields at Fargo, ND, where the growing season is short, were <5.00 kL ha^{-1}. Adapted sugar beet hybrids show better promise than fodder beet as a fuel crop in the USA, since sugar beet produces an equal or greater quantity of fermentable sugar, has less bulk to transport, more extractable sugar per unit mass, and resistance to prevalent sugar beet diseases.

VALVERDE, R. A., S.-H. LIU, B. W. FALK, and J. E. DUFFUS. Comparison of several luteoviruses by serology, dsRNA and molecular hybridization. Phytopathology 77:1706. 1987.

Different luteoviruses, including several isolates of beet western yellows virus (BWYV) and barley yellow dwarf virus (BYDV) were compared by DAS-ELISA, dsRNA and molecular hybridization using cDNA clones to BWYV and BYDV. All BWYV isolates tested reacted with antiserum to BWYV. All other luteoviruses reacted only with their homologous antisera. Obtained dsRNA profiles were useful to differentiate some but not all luteoviruses analyzed. cDNA clones to BWYV-mild hybridized with all BWYV isolates. Nevertheless a clone specific for BWYV-severe hybridized only with BWYV-severe. A cDNA clone to BYDV-PAV hybridized with NY-PAV and NY-MAV, but not with any of the other luteoviruses These results reemphasize the biological and molecular diversity among luteoviruses and their isolates.

WHITNEY, E. D. Identification and aggressiveness of Erwinia carotovora subsp. betavasculorum on sugar beet from Texas. Plant Disease 71:602-603. 1987.

Erwinia carotovora subsp. betavasculorum was positively identified from cultivar HH 23 from the Hereford, TX, area by a microprecipitin test, growth on Miller-Schroth selective medium, and a pathogenicity test on a susceptible cultivar. The aggressiveness of strains varied from mild to moderately severe; however, none of the Texas strains was more aggressive than a California isolate and no resistance-breaking biotypes were detected. Known sources of resistance should provide disease control.

WHITNEY, E. D. High levels of resistance to powdery mildew in Beta maritima. Phytopathology 77:1723. 1987. (Abstract)

Powdery mildew of sugar beet caused by Erysiphe polygoni became epidemic in the United States in 1974 and has reoccurred each year since. Resistance breeding has produced tolerant cultivars; however additional sources of resistance would be desirable. Fifty-five Beta maritima accessions from Europe were greenhouse tested for reaction to E. polygoni. Seven accessions did not show visible mildew on some plants. These accessions were field tested under natural infection. All of the accessions that had mildew free plants in the greenhouse also had mildew free plants in the field. Frequency of plants without mildew ranged from 13-88% in the greenhouse and 12-93% in the field. Susceptible sugar beets were heavily mildewed in both greenhouse and field tests. In a greenhouse test the most resistant sugar beet cultivar had a reading of 2.7 and 3.1 (scale 0-9) at 2 and 4 weeks after inoculation while F_1 plants from crosses between resistant B. maritima plants were 0.0 at both readings.

WHITNEY, E. D. and B. E. MACKEY. Differences in aggressiveness of Erwinia carotovora subspecies betavasculorum strains and their reaction to sugar beet cultivars. Plant Disease 72: (In press). 1988.

In tests conducted in the greenhouse strains of Erwinia carotovora sp. betavasculorum caused significantly different amounts of disease in sugar beet. The apparent aggressiveness of the strains varied due to a cultivar resistance by strain interaction. A large difference in cultivar resistance to individual strains was also found. In tests conducted in the field aggressive strains infected a higher percentage of beets than less aggressive strains, 19 versus 3.7%, increased the percentage rot per diseased beet from 8.7 to 44.3% and the disease index from 0.2 to 3.5%. Because of the cultivar by strain interactions we suggest the use of several strains when selecting for resistance and further that the most aggressive strains of the bacterium be used, as use of such strains allowed a more reliable identification of the most resistant plants.

WHITNEY, E. D. Immunity to Erysiphe polygoni in Beta maritima accessions from Europe. Phytopathology 78:1528. 1988. (Abstract)

Powdery mildew caused by E. polygoni is a serious disease of sugar beet, B. vulgaris. In 1987 we reported some wild beets, B. maritima, visually free of mildew. Within crosses from mildew free plants, progenies were obtained that also were mildew free. Resistant progenies, susceptible beet, and a nonhost Chenopodium amaranticolor were inoculated, incubated in a growth chamber, and the fungus studied microscopically. Leaf discs taken at 1, 2, 4, and 6 days after inoculation were cleared by boiling in 70% ethanol for 30 min, stained for 5 min in lactophenol cotton blue, destained in water and semi-permanent mounts made with glycerin and water (1:1, v/v).

Spore germination and appressorial initiation were similar in beet, B. maritima and C. amaranticolor. Mycelial initiation occurred in beet within 24 hrs. at 24C. E. polygoni appeared morphologically similar on B. maritima and C. amaranticolor with aborted appressoria and no mycelial growth. Only beet had mildew following incubation (1 mo) in a greenhouse suggesting immunity in B. maritima to E. polygoni from California.

WHITNEY, E. D. Identification, distribution, and testing for resistance to rhizomania in Beta maritima. Plant Disease 72: (In press). 1988.

Many plants with a high level of resistance to rhizomania were found in 17 of 63 (27%) accessions of Beta maritima tested in either the greenhouse, field, or both. Resistance to rhizomania was estimated by disease reaction or by ELISA values for beet necrotic yellow vein virus (BNYVV) from plants that were grown in infested soil. Some resistant plants grown in the greenhouse and field-grown plants were virus free as measured by ELISA. The number of plants within each accession that was free of the virus ranged from a few plants to all plants. Resistant accessions were from Denmark, England, France, and Italy. All plants tested were susceptible to the fungus, Polymyxa betae, the vector of BNYVV. Successful crosses were made between sugarbeet (B. vulgaris) and B. maritima. Resistance appeared to be dominant because F_1 plants (resistant x susceptible) were all resistant or segregated for resistant plants. A significant correlation ($r = 0.77$) occurred between the mean greenhouse and field ELISA (BNYVV) values from 15 resistant types. Also, significant correlations based on a disease index were found among three greenhouse tests, between disease indices (DIs) from the greenhouse, and field ELISA and between greenhouse DIs and field root symptoms. Other correlations, greenhouse DIs versus greenhouse ELISA, greenhouse ELISA versus field DIs and field DIs versus field ELISA were not significant. These data suggest that plants of B. maritima with resistance to rhizomania can be selected either in the greenhouse or the field and that this resistance can be transferred to sugarbeet. This is the first detailed report of rhizomania resistance in B. maritima.

WHITNEY, E. D. and F. N. MARTIN. Preplant soil fumigation for the control of rhizomania of sugarbeet. Proc. 5th Internat. Congr. Plant Pathologists, Kyoto, Japan, p. 454. 1988. (Abstract)

Dichloropropene (Telone II), sodium N-methyl-dithiocarbamate (Vapam), chloropicrin, and methyl bromide were tested for the control of rhizomania. The fumigants were injected to a depth of 17 cm and the soil surface sealed by compaction and sprinkler irrigation or in the case of methyl bromide by a plastic tarp. Methyl bromide provided the most effective control increasing yield by 280% and sucrose concentration by 54%. However, Telone II was the most cost effective of the treatments tested. Telone increased yield by 75 to 249% and sucrose by 8 to 45%.

WHITNEY, E. D. Resistance to rhizomania in Beta maritima accessions from Europe. Proc. 5th Internat. Congr. Plant Pathologists, Kyoto, Japan, p. 454. 1988. (Abstract)

Thirty of 63 B. maritima L. accessions tested either in the greenhouse, field, or both had plants that did not show symptoms of rhizomania. Results from ELISA tests of greenhouse and or field grown plants from 17 accessions and their F_1 hybrids with susceptible sugarbeet (B. vulgaris L.) showed plants that appeared to have virus free fibrous roots. Resistance appeared to be dominant. Plants within some accessions varied from being virus free to susceptible suggesting both qualitative and quantitative resistance in B. maritima. Resistant accessions were from Denmark, England, France, and Italy.

WHITNEY, E. D. The enzyme-linked immunosorbent assay (ELISA) as a tool for resistance breeding for rhizomania control. J. Sugar Beet Res. 26:A28. 1989. (Abstract)

Rhizomania is a serious fungal transmitted virus disease of sugar beet in many sugar beet production areas of the world. Resistance to beet necrotic yellow vein virus has been identified in sugar beet and In Beta maritima, a close relative of sugar beet. Procedures have been developed for field and greenhouse testing to evaluate sugar beet, B. maritima and their interspecific hybrids. ELISA values within a test may vary from 0.001 to 1.999 in greenhouse and field grown plants and from 0.034 to 1.999 within a cultivar. The values for noninoculated sugar beet ranged from 0.001 to 0.072. The difficulty that arises is the inability to identify a definitive point between whether the virus is present or absent in the test plant. The ELISA is not the panacea one might hope in resistance testing but does have a place in confirming the reaction of a field or greenhouse tested plant.

WHITNEY, E. D., D. C. ERWIN, and S. R. TEMPLE. Biology, inoculum production, and testing for resistance to Phytophothora drechsleri in sugar beet. J. Sugar Beet Res. 26:A28. 1989. (Abstract)

P. drechsleri causes a serious root rot of sugarbeet during hot weather when the soil is saturated with water. We have studied factors that may influence inoculum production and testing for resistance. Corn meal agar and V-8 agar were equally good for mycelial growth and better than lima bean agar. The optimum temperature for growth was between 28 & 30C with no growth at 5 and 40C. The fungus grew better at a pH of 7.5 than at 4.2. Soil extract stimulated sporangial production more than sterile soil extract, tap water or distilled water. Zoospores and infested milo seed were effective as inoculum in greenhouse tests. Cultivar SP 85303-0 was highly resistant in greenhouse tests and in a field test when compared to seven other cultivars.

WHITNEY, E. D. Beta maritima as a source of powdery mildew resistance in sugar beet. Plant Disease 73 (In press). 1989.

Fifty-five accessions of Beta maritima L. were tested in the greenhouse for resistance to Erysiphe polygoni D. C. from sugar beet, Beta vulgaris L. Host reaction varied from highly susceptible to visually free of mildew. Field tests of selected accessions and accessions resistant to rhizomania showed high levels of resistance to powdery mildew under natural conditions. Crosses between plants that were free of mildew in greenhouse tests produced some families that were also mildew free. Outcrosses to sugar beet were fruitful and also showed high resistance to mildew. High levels of resistance in B. maritima were found in accessions from Denmark, France, Greece and The Netherlands. These accessions should provide new sources of resistance to powdery mildew in sugar beet.

YU, M. H. Production and reproductive behavior of monoploid sugarbeet. Crop Sci. 27:461-465. 1987.

The rate of occurrence of monoploids in sugarbeet was 0.017% Meiotic pairing in the monoploids indicated the presence of three or more duplications that involved at least six of the nine chromosomes. Chromatid bridges and fragments occurred in more than 2% of microsporocytes. Only gametes that developed from restitution nuclei and contained a complete set of sugarbeet chromosomes did not abort. Seed setting was rare, and not every monoploid sugarbeet produced viable seed. Sugarbeet monoploids gave rise to monoploid progeny through pollination at a rate of 1.49%, which was 80 times higher than that from pollinating diploids. The progeny plants also contained 18, 19, 27, 36, and 18/36 chromosomes. A great majority (92.3%) of progenies were diploids. The 19-chromosome progeny was the only aneuploidy class recovered. It may not be possible to establish monosomic series of sugarbeet genotypes through pollination because gametes without an intact genome do not survive.

YU, M. H. Ploidy level and leaf texture variations following sugarbeet regeneration. Genome 30 (Suppl. 1):437. 1988.

Somaclonal variations in sugarbeet regenerants involved leaf morphology and ploidy alterations. Over 60% of regenerants maintained the same chromosome number as the donors. The next frequent type was chromosome doubling, followed by mixoploids and other aneuploids. Progenies resulting from outcrosses of these regenerants created additional aneuploidy classes. Leaf intumescence occurred in several regenerants. When diploidy intumescent plants were crossed to normal sugarbeets, about 8% of the progeny exhibited the trait. These progenies, however, showed lesser but varying intensity of intumescence than their female parents.

YU, M. H. Callus induction and differentiation from leaf explants of different species of the genus Beta. Crop Sci. 29:205-209. 1989.

The noncultivated Beta species are a potential source of germplasm for sugarbeet improvements, yet their in vitro regeneration has rarely been explored. To investigate the regeneration ability of beet species across all four sections of the genus Beta, leaf explants from 16 germplasm sources were cultured on MS medium containing N^6-benzyladenine. There was a positive association between leaf expansion and callus formation. Leaf explants from nine Vulgares and Corollinae species that became highly swollen generally produced a larger mass of callus than that of Nanae and Patellares. A large amount of callus was induced in B. vulgaris, B. maritima, B. intermedia, and B. macrocarpa. Callus formed in more than one cycle. Rooting occurred with nine species, none belonging to Nanae or Patellares. Shoots were regenerated only with B. vulgaris and B. macrocarpa. Explants from most Beta species exhibited optimum callus formation and differentiation at 31° C, nonetheless, at 33° B. atriplicifolia, B. lomatogona, and B. intermedia responded.

Root-knot nematode and its infection of sugarbeet

M. H. Yu

Root-knot nematodes, Meloidogyne spp., are destructive pest of sugarbeet. They can be a serious problem in sugarbeet growing regions where they occur. These nematodes are parasitic to an extensive range of host plants, not to mention their involvement with fungi, bacteria, and viruses in disease complexes that rank them among the top major pathogens affecting sugarbeet production. Culture control measures, such as crop rotation, therefore, becomes impractical in many geographic areas. Chemical control of root-knot nematodes has been commonly used and is usually successful. However, nematicides or chemicals can be expensive and may cause environmental safety problems. In other words, they should be used only when crop yields more than pay the cost of treatment with no damage to the environment. Thus breeding sugarbeet genotypes resistant to these nematodes becomes very important in the disolution of this problem.

In the United States, severe losses from root-knot nematodes are attributed to M. incognita and M. javanica; M. hapla, M. arenaria, and M. naasi also cause problems. Serious damage by these nematodes include many sugarbeet growing areas in California, Arizona, Texas, Colorado, Idaho, Utah, and Oregon. Damage is generally confined to coarse textured soil. Southern and middle San Joaquin Valley areas of California are among the most infected regions. Severe damage could occur if control methods are not applied.

Although the seven or eight species of this Meloidogyne genus differ from one to another in some ways, they all have substantially the same life history. Newly hatched second-stage larvae occur free in the soil and may invade any part of the plant that contacts moist soil; however, the larvae usually enters the root near the root tip. Soon after the nematode larva has successfully entered the root, it finds a suitable feeding site near the root vascular tissue in the endodermis. Migration then ceases, and feeding and molting proceeds. Feeding by root-knot nematodes caused a series of host responses, such as formation of galls and induction of giant cells nearby the feeding site within the tissue. During this period, the male and female characteristics of this nematode become evident. As the larva matures from second-stage to adult, the female develops into a pear-shaped nematode embeded completely within the root tissues. The male larva also becomes swollen during this metamorphism but emerges from the last molt as an elongated worm.

The female may or may not require fertilization by the male before eggs are produced. Various numbers, up to several hundreds, of eggs usually are laid in a gelatinous matrix by the females outside the body. The egg mass may rupture the root epidermis and protude into the soil or remain buried within the root tissues. Hatching occurs either in the soil or from eggs embedded in the root tissues. If hatching occurs in the soil, the larvae may invade the same root or may migrate to another root. Males migrate and seek out sedentary female with which to copulate. The life cycle of root-knot nematode can be completed under suitable conditions within one month.

The susceptibility of sugarbeet germplasm to the root-knot nematodes has not been investigated. Various sources of sugarbeet cultivars were acquired to search for their possible existence of tolerance or resistance to these nematodes. Experiment was conducted in both the laboratory and greenhouse. Early infection by the nematode larvae was characterized by the formation of small galls and exudation of egg matrices on the root systems of sugarbeet seedlings.

The preliminary observation from this study showed that gall formation commonly occurred on seedlings of those accessions under investigation. When galls formed on root systems of the inoculated seedlings were rated on a scale of 1 to 5 a great majority of accessions were rated 5, based on some 700 sample observations. Under the present investigation conditions the identifiable gall number per treatment ranged from 1.0 to 4.0. The detectable egg mass per gall number ranged from 16 to 34%.

Source nematode	No. galls	Egg mass/ gall (%)	No. entry
M. incognita race 1	3.3	22	231
" " race 3	3.8	34	48
" " race 4	2.7	34	61
M. javanica	3.4	34	234
M. hapla	1.0	17	57
M. arenaria	4.0	16	133

It should be mentioned that gall formation does not necessarily indicated susceptibility of a plant. Susceptibility of a plant should be based on the reproductivity of these nematodes after infection. The tested plants can be transplanted and grown in a greenhouse to further investigate their tolerance or resistance to root-nematodes.

THE EFFECT OF FUMIGATION ON RESISTANT CULTIVARS FOR RHIZOMANIA CONTROL

E. D. Whitney, I. O. Skoyen, and R. T. Lewellen

In Sugarbeet Research 1985, Whitney et al. (2) reported the efficacy of fumigants for rhizomania control. Since then rhizomania resistant cultivars have become available for testing in the United States and Europe. The purpose of this research was to estimate the efficiency of resistant cultivars under fumigated and nonfumigated conditions.

MATERIALS AND METHODS

Cultivars US H11 (susceptible) and Rhizosen, Rizor-3 and Y39(C3) (resistant) were grown in highly viruliferous Polymyxa beta infested soil. Telone II, dicloropropene, at 8.5 gallons per acre was injected 3 weeks preplant, at a 7 inch depth in beds 28 inches apart. The experimental design was a split plot with fumigation as main plots and cultivars as subplots. Subplots were two rows wide and 22 feet long with six replications per treatment. Temik was applied for nematode control and Bayleton for mildew control. Plots were seeded May 19 and harvested Oct. 31, 1988. At harvest gross sugar, root yield, percentage sucrose, beets per 100 feet of row, percentage soluble solids, percentage nonsucrose soluble solids, raw juice apparent purity, percentage clean beets, and a disease index (0 to 6) were obtained.

RESULTS AND DISCUSSION

There was a variety and fumigation effect for all variables except beets per 100 feet of row (nonfumigated) and a variety by fumigation effect for all variables except for gross sugar yield. The CV's were all low except for the disease index for fumigated plots. Table 1 shows the data for the variables evaluated.

The three resistant cultivars reacted similiarly when grown in fumigated and nonfumigated conditions suggesting comparable resistance. The susceptible cultivar yielded less than the resistant cultivars in both fumigated and nonfumigated soils. Resistant and susceptible cultivars yielded more in fumigated soils than in nonfumigated soils. The effect of continuous beet culture in the test plots could have had a greater effect on performance in the nonfumigated plots than in fumigated plots. However, these data are similar to those of T. A. Babb et al. (1) from sugarbeets grown in sugarbeet rotations where rhizomania was present. These data suggest that in an integrated approach, fumigation of infested soil plus the growing of resistant cultivars when possible will provide significant increases in yield and beet quality.

LITERATURE CITED

1. Babb, T. A., J. P. Mueller and C. A. Frate. 1989. An integrated approach for the control of rhizomania. J. of Sugar Beet Research 26(1):A1-A2 and printed report (25th general meeting, American Society of Sugar Beet Techno. pgs 1-14).
2. Whitney, E. D., F. Martin, J. E. Duffus and R. T. Lewellen. 1985. Fumigation for the control of rhizomania. Sugarbeet Research 1985:A7-A9.

Table 1. Results of four sugarbeet cultivars tested under nonfumigated and fumigated conditions with Telone II at 8.5 gal per acre.

Varieties	Gross Sugar, lbs/a		Root Yield, t/a		% Sucrose		Beets/100 ft row		% Soluble Solids	
	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum
R39 (C3)	8190	5342	23.7	16.6	17.3	16.1	140	151	20.8	20.0
Rizor-3	7873	5115	22.9	15.4	17.2	16.6	145	136	20.8	20.5
Rhizosen	7808	4881	23.8	15.7	16.4	15.6	142	142	19.2	19.2
U.S. 11	4515	1430	17.4	6.8	13.0	10.5	153	147	16.3	14.8
LSD 0.05	515	941	2.2	2.3	1.1	0.9	9.6	NS	1.1	0.7
CV %	5.9	14.4	8.1	13.4	5.3	4.9	5.4	7.7	4.7	3.1

Varieties	% Non-Sucrose Soluble Solids		Raw Juice Apparent Purity		% Clean Beets		Disease Index	
	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum
R39 (C3)	3.5	3.9	83.1	80.6	96.0	90.2	0.53	2.2
Rizor-3	3.6	3.8	82.8	81.4	96.2	90.6	0.47	1.7
Rhizosen	2.8	3.6	85.3	81.4	97.8	87.7	0.65	2.7
U.S. 11	3.4	4.3	79.4	70.9	97.5	75.5	1.00	4.4
LSD 0.05	0.3	0.4	1.4	3.0	1.1	4.4	0.38	0.3
CV %	7.0	8.5	1.4	3.1	1.0	4.1	47.1	8.6

DEVELOPMENT OF MONOCLONAL ANTIBODIES SPECIFIC FOR *POLYMYXA BETAE*

(BSDF PROJECT 140)

JAMES S. GERIK AND JAMES E. DUFFUS

A hybridoma laboratory has been started and mouse myeloma cell cultures have been successfully established. Mice have been immunized with soluble proteins extracted from roots infected with *P. betae* and cyst of *P. betae*. Hybridomas have been constructed from the spleen cells of the immunized mice and the myeloma cells. Several of the hybridoma cultures were found to excrete antibodies and these cultures were cloned. The clones are being evaluated as to their usefulness as producers of antibodies specific to *P. betae*.

GERMPLASM DEVELOPMENTS

R. T. Lewellen and I. O. Skoyen

Thirteen germplasm lines of sugarbeet developed or improved in the breeding program at Salinas were officially released in 1989. Seed will be made available after August 1, 1989. These germplasm lines represent our ongoing efforts to combine multiple disease resistance with factors for high productivity and to develop enhanced source populations for commercial breeders. The following descriptions are abbreviated versions of the official release statements and are included here so that they can readily be related to their performance in the following trial summaries.

C47: A multigerm, self-sterile line with combined disease resistance. Four cycles of phenotypic recurrent (mass) selection for resistance to virus yellows, powdery mildew, and Erwinia root rot and for sucrose concentration and root size were made following the development of a population from lines E36 (C36) & E37 (C37) crossed to Y401A (C01), Y631E (C31), Y646 (C46), & Y641 (C91). As a line, C47 has high sugar yield. It was developed and tested as lines Y47 (e.g., Y947, Y747, Y547).

C47R: A line similar to C47, but after the first cycle of selection for virus yellows, five cycles of mass selection for resistance to rhizomania were made. C47R is nearly equal to C39R for resistance to rhizomania. C47R has been developed and tested as line R47 (e.g., R947C5, R847C4, Y747C3, etc.).

C93: A multigerm, self-sterile line with nearly identical developmental history as C47. It was derived from composite crosses of E36 & E37 with Y723 & Y726. Y723 (C15) from US 15 and Y726 from US 56/2 were developed by mass selection for resistance to virus yellows. As a line, C93 has relatively high sucrose content in a disease resistant background. It was developed and tested as line Y48.

C94: This multigerm, self-sterile line is the fourth cycle synthetic selected for resistance to rhizomania. It was developed from full-sib progenies selected for resistance to rhizomania from Colorado germplasm, including FC703, FC705, FC709, GW674, MW391, GW359, GW777, and GW602. Cycles 2-4 were by mass selection. Except for good tolerance to rhizomania, C94 appears to have typical disease resistance for this germplasm base. It is moderately resistant to rhizoctonia (Hecker). C94 was developed and tested as line R20.

C28: This multigerm early generation line segregates for a major gene that conditions a high level of resistance to rhizomania. Resistance was derived from one "chard-like" plant in PI 206807 from the Ames collection.

C312 (C827): A monogerm, O-type, self-fertile, R:rr hypocotyl line with good resistance to LIYV and tolerance to virus yellows. It was derived from popn-755 (C310) as an S_1 line and discriminated in S_1-TX progeny tests at Salinas and Brawley. It is similar to C301 and C306 for reaction to LIYV and sugar yield combining ability but with improved sucrose content and juice purity. It has been advanced and tested as line 827 (e.g., 9827, 6827, etc.).

C313 (C830): A line similar to C312 with good resistance to LIYV and powdery mildew. It has been advanced and tested as line 830.

C762-17: A monogerm, self-fertile, green hypocotyl line derived from the cross [(popn-755 x C546) x C718]. C762-17 is a very good O-type line with moderate resistance to LIYV and high resistance to CTV but is susceptible to Erwinia. It has high combining ability for sugar yield. It has been advanced and tested as line 212-17 and 762-17.

C766-23: Is a monogerm, O-type, self-fertile, red hypocotyl line derived from the S_2 from popn-767 (= popn-755 x C564). It was originally discriminated in an S_2-TX progeny evaluation. C766-23 has high GCA with both good root yield and sucrose traits and a good combination of disease resistances. It and its hybrids have long petioles and relatively small blades and the canopy is lighter green than C766-62. It was advanced and tested as line 766-23 (e.g., 9766-23, 8766-23, 7766-23, etc.).

C766-62: Is a monogerm, O-type, self-fertile, green hypocotyl line. It is a sister line of C766-23 but has quite different traits. C766-62 is dark green and is outstanding for its combined disease resistance, particularly for virus yellows and Erwinia. However, it is susceptible to powdery mildew. It has good GCA but appears to have high GCA when its hybrids are infected with either or both BYV or BWYV. It was advanced and tested as line 766-62.

C790-92: Is a monogerm O-type, self-fertile, green hypocotyl line developed by single-seed-descent from popn-790. It is a sister line to C790-69 and has good combining ability. It was advanced and tested as line 790-92.

C796-43: Is a monogerm, O-type, self-fertile, green hypocotyl line derived from popn-796 by S_1-TX evaluation. It is a sister line to C796-22 but has improved yield and sugar characteristics. It was advanced and tested as line 796-43.

C742-24: Is a self-fertile, green hypocotyl line with good monogerm and O-type traits. It was selected from popn-743 (C789/2) by S_1-TX evaluation. It was advanced and tested as line 742-24.

For the monogerm, O-type, self-fertile lines, the corresponding CMS near-equivalents will be made available to expedite testing.

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BYV INFECTED HALF-SIB PROGENY TESTS OF C31/6 and popn-776

Although not summarized in this report, an important segment of our 1988 virus yellows resistance breeding project was to try to isolate superior genotypes for BYV resistance from C31/6 (MM) and popn-776 (mm). At Davis, Dr. Steve Temple tested 100 half-sib (HS) families from C31/6. At Salinas, the same C31/6 HS progenies were tested as were 30 HS families from popn-776.

Sugar yield under BYV infected conditions was the primary criterion to make selections. At both Davis and Salinas, a wide dispersion occurred for the measured HS traits. In general, except for sucrose content, the rankings at Davis and Salinas were not highly correlated. However, a number of HS progenies performed well at both locations.

On the basis of the progeny tests, selections were made so that two new synthetics could be established: Cycle 1, Davis synthetic and Cycle 1, Salinas synthetic. In addition, 6 specific HS families with combined superior performance over most traits and at both locations were selected for seed production. After seed production in 1989, these synthetics and lines and their experimental hybrids will be evaluated at Salinas and Davis under BYV inoculated and noninoculated conditions in 1990.

FIELD VARIETY TRIALS, SALINAS, CALIFORNIA, 1988

Location: USDA-ARS Agricultural Research Station

Soil Type: Sandy loam (Chualar series)

Previous Crops: 1988 Sugarbeet test areas, Spence Field: Block 3, 22 Acres; fallow 1985-86, sugarbeets 1984, oat hay 1987.

Fertilizer Used: Preplant: 430 lbs/A 8:20:10 broadcast and chiselled in prior to listing. Before seeding, about 330 lbs/A ammonium sulfate was Bye-Hoe incorporated in a 9-inch band into the beds.

Supplemental nitrogen: One to three applications, as sidedress ammonium sulfate or by sprinkler system as 32% nitrogen in a liquid formulation.

Total fertilization (lbs/A);	N	P_2O_5	K_2O
Block 3	270	86	43

Summary: 1987-88 Tests at Salinas (Spence Field):

Test No.	Sowing Date 1987-88	Thinning Date 1988	Test Entries No.	Reps No.	Plot Row No.	Plot Lgth. Ft.	Harvest Date 1988	Test Design
188	11/24	2/4-2/8	100	3	1	16	-------	1/
288	11/24	2/4-2/8	40	3	1	16	-------	1/
388	11/24	2/4-2/8	30	2	1	16	-------	1/
488	11/25	2/4-2/8	160	3	1	16	-------	1/
588	11/25	2/4-2/8	160	3	1	16	-------	1/
688	1/25	3/7	8	8	2	30	9/27-28	RCB
788	1/25	3/7	32	8	1	30	9/13-14	RCB
888	1/25	3/8	32	8	1	30	9/19-20	RCB
988	1/25	3/8	32	8	1	30	9/20-21	RCB
1088	1/28	3/9	6	8	1	30	9/26	RCB
1188	2/1	3/10	26	8	1	30	9/26-27	RCB
1288	1/26	3/10	32	8	1	30	9/22-23	RCB
1388	1/26	3/10	32	8	1	30	9/29-30	RCB
1488	1/26	3/10	32	8	1	30	10/3-4	RCB
1588	2/19	3/23	30	4	1	16	11/7	RCB2/
1688	2/19	3/23	100	3	1	16	11/3-4	RCB2/
1788	2/19	3/23	16	8	1	30	11/2	SB3/
1888	2/19	3/24	8	8	1	30	11/1	SB3/
2088	2/18	3/24	32	8	1	30	10/31-11/1	SB3/
2188	2/18	3/24	32	8	1	30	10/17-18	SB3/
2288	2/18	3/25	16	8	1	30	10/6-7	SB3/
2388	2/18	3/25	32	8	1	30	10/13-14	RCB
2488	2/18	3/28	32	8	1	30	10/4-7	RCB
2588	2/18	3/29	8	8	2	30	9/28	RCB
2688	4/21	5/17	240	1	1	8	-------	4/
2788	4/21	5/17	8	1	8	65	-------	5/

Test No.	Sowing Date 1987-88	Thinning Date 1988	Test Entries No.	Reps No.	Plot Row No.	Plot Lgth. Ft.	Harvest Date 1988	Test Design
2888	4/21	5/17	80	6	1	16	PM Eval.	
2988	4/22	5/18	32	1	1	20	PM-ERR Obs	
2988	4/22	5/18	176	2	1	20	PM-ERR Obs	
3088	4/22	5/18	192	2	1	20	PM-ERR Obs	
3188	4/22	5/19	120	1	1	20	PM-ERR Obs	
3288	4/18	5/20	16	6	1	30	10/11-12	SB[6]/
3388	4/18	5/20	4	8	1	44	10/12	SB[6]/
Summary: 1988 Rhizomania Tests (Research Station Field):								
RZM 188-1	5/18	6/5	32	4	1	16		RCB
RZM 188-2	5/18	6/5	16	8	1	16		RCB
RZM 188-3	5/18	6/6	16	4	1	16		RCB
RZM 188-4	5/18	6/6	4	8	1	16		RCB
RZM 188-5	5/18	6/7	16	8	1	16		RCB
RZM 188-6	5/18	6/7	64	3	1	7		RCB[7]/
RZM 188-7	5/18	6/8	32	2	1	16		RCB[8]/
RZM 288-1	7/22	8/10	13	-	1	16		RCB[9]/
RZM 288-2	7/22	8/10	4	8	2	16		RCB
RZM 288-3	7/22	8/10	16	8	1	16		RCB
RZM 288-4	7/22	8/11	32	4	1	16		RCB
RZM 288-5	7/22	8/11	38	-	-	--		RCB[10]/
RZM 388-1	7/21	8/11	30	2	1	13		RCB[8]/
RZM 388-2	7/21	8/12	16	6	1	13		RCB
RZM 388-3	7/21	8/12	33	2	1	13		RCB[11]/
RZM 388-4	7/21	8/12	30	4	1	13		RCB
RZM 388-5	7/21	8/15	4	6	2	13		RCB
RZM 388-6	7/21	8/15	24	6	1	13		RCB
RZM 388-7	7/21	8/15	94	1	1	13		RCB[12]/
RZM 388-8	7/21	8/15	17	1	1	12		RCB[13]/
RZM 388-11	7/21	8/15	12	6	1	12		RCB

1/ Bolting tendency observation trials.
2/ BYV infected half-sib progeny tests.
3/ BYV infected vs noninfected tests.
4/ Indexing annuals for bolting tendency.
5/ BYV-ERR-PM mother root selection.
6/ Rhizomania infested vs noninfested tests.
7/ Eval. Ames PI-#'s for BWYV and rhizomania.
8/ Rhizomania eval. of TX of 6235,6,7aa x 767.
9/ Nematode resistance eval. from B883.
10/ Rhizomania resistant mother root sel.
11/ Rhizomania resistant progeny test.
12/ Inheritance of resistance to rhizomania.
13/ Rhizomania resistance from PI 206407.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light sprinkler irrigations were used.

Herbicide use: Norton EC at an average rate of 3 qts/A and 2.5 qts/A Pyramin FL, were sprayed post plant and sprinkled in with 1/2 to 3/4 inch water.

Disease and insects: Natural virus yellow infection (BWYV) was light during 1988 season. Black bean aphid infestation was light in 1988. Test field sprayed once with Meta Systox R.

Powdery mildew was moderate in 1988 when not controlled and appeared first (late June) in the earliest seeded tests. Good control was obtained with a single application of Bayleton. Spray applications of Bayleton at 8-10 oz ai/A.

Natural infection of Erwinia soft rot was light in susceptible lines in 1988. Impact on yield was slight. Counts of rotted roots were made at harvest. Roots with rot were eliminated from the sugar samples.

Sugarbeet nematode was not observed in 1988 test areas.

Rhizomania was not observed in 1988 spence field tests. Severe in rhizomania tests.

Remarks: 1988 test area had Telone II at 18 gal./A chiseled in broadcast, in October 1988 for nematode and rhizomania control.

TEST 1088. SINGLE-CROSS EVALUATION OF CMS LINES, SALINAS, CA., 1988

6 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 28, 1988
Harvested: September 26, 1988

Variety	Description		Acre Yield		Sucrose	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity
	MS	Male	Sugar Lbs	Beets Tons	%	%	No.	%	%
Y731H26	C309	F86-31/6	15,275	44.94	16.99	0.0	136	2.96	85.1
Y731H89	C790-68	F86-31/6	14,809	45.18	16.38	0.9	131	2.96	84.6
Y731H87	C790-55	F86-31/6	14,389	44.16	16.31	1.1	131	2.87	85.0
Y731H70	5766-62	F86-31/6	14,348	44.29	16.22	0.3	124	2.81	85.2
Y731H66	5766-23	F86-31/6	14,146	44.34	16.00	0.6	128	2.75	85.2
Y731H72	C718	F86-31/6	14,078	47.15	14.85	0.6	125	2.76	84.2
Mean			14,508	45.01	16.12	0.6	129	2.85	84.9
LSD (.05)			NS	NS	0.96	NS	NS	NS	NS
C.V. (%)			10	6.50	5.90	177.5	9.2	10.00	1.6
F value			0.8NS	1.2NS	4.5**	1.1NS	1.1NS	0.9NS	0.7NS

Note: This test was adjacent to Area 4 coded variety trial.

TEST 788. TEST OF S_1 AND FS PROGENIES FROM MULTIGERM POPN-906, SALINAS, CA., 1988

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 25, 1988
Harvested: September 13-14, 1988

Variety	Description[1]/		Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity
	Female	Male	Lbs	Tons	%	%	%	No.	%	%
7767H101-11	6235-21aa	6767	16,677	49.84	16.79	1.4	0.0	146	2.44	87.2
7767H103-29	6237-13aa	6767	15,664	48.08	16.27	1.1	0.3	136	2.57	86.3
7767H101-14	6235-28aa	6767	15,648	46.45	16.88	2.3	0.0	134	2.78	85.8
7767H101-6	6235-12aa	6767	15,591	46.29	16.84	5.2	0.2	132	2.41	87.4
7767H103-32	6237-16aa	6767	15,539	44.77	17.36	0.2	0.0	135	2.81	86.0
7767H102-18	6236-2aa	6767	15,499	46.28	16.78	1.1	0.0	147	2.58	86.6
7767H101-7	6235-14aa	6767	15,478	44.34	17.46	0.8	0.0	134	2.77	86.3
7767H102-23	6236-7aa	6767	15,428	44.99	17.14	0.9	0.0	136	2.64	86.6
7767H101-12	6235-23aa	6767	15,353	45.38	16.92	1.5	0.6	131	2.71	86.1
7906H68	6767HO	6235,6,7	15,249	45.69	16.71	0.2	0.0	140	2.32	87.7
7767H101-9	6235-16aa	6767	15,224	44.95	16.94	2.3	0.0	136	2.54	86.9
7767H102-26	6236-10aa	6767	15,181	44.78	17.01	1.9	0.0	136	2.82	85.7
7767H103-34	6237-18aa	6767	15,146	44.03	17.22	2.1	0.2	141	2.69	86.4
7767H102-20	6236-4aa	6767	15,122	45.34	16.69	0.6	0.0	135	2.53	86.8
7767H101-10	6235-17aa	6767	14,853	44.17	16.85	2.8	0.2	128	3.00	84.8
7767H103-28	6237-12aa	6767	14,811	44.40	16.65	1.8	0.3	134	2.71	85.9
7767H103-33	6237-17aa	6767	14,801	43.96	16.84	0.2	0.0	133	2.83	85.6
7767H101-1	6235-1aa	6767	14,800	42.79	17.27	5.5	0.0	139	3.01	85.1
7767H102-19	6236-3aa	6767	14,772	44.97	16.48	1.0	0.2	141	2.67	86.0
7767H103-30	6237-14aa	6767	14,755	42.83	17.22	3.0	0.0	135	2.63	86.7
7767H102-25	6236-9aa	6767	14,708	43.62	16.86	0.9	0.0	132	2.75	85.9
7767H102-17	6236-1aa	6767	14,650	45.31	16.16	0.9	0.0	137	2.56	86.3
7767H103-31	6237-15aa	6767	14,649	43.19	16.96	0.2	0.0	140	2.69	86.3
7767H102-27	6236-11aa	6767	14,584	43.11	16.90	1.8	0.0	136	2.62	86.5

TEST 788. TEST OF S_1 AND FS PROGENIES FROM MULTIGERM POPN-906, SALINAS, CA., 1988
(Continued)

Variety	Description[1]/		Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity
	Female	Male	Lbs	Tons	%	%	%	No.	%	%
7767H101-16	6235-34aa	6767	14,546	44.60	16.38	1.7	0.0	144	2.63	86.1
7767H102-21	6236-5aa	6767	14,363	42.35	16.99	0.2	0.2	142	2.72	86.1
7767H102-22	6236-6aa	6767	14,330	42.76	16.77	1.5	0.3	142	2.80	85.7
Rhizosen	Holly (1/5/88)		14,259	41.68	17.13	0.3	0.0	135	2.40	87.7
7767H101-3	6235-5aa	6767	14,215	42.84	16.60	3.2	0.0	133	2.66	86.1
7767H101-5	6235-10aa	6767	14,193	42.72	16.67	4.1	0.0	129	2.89	85.1
7767H102-24	6236-8aa	6767	14,051	43.48	16.16	1.5	0.3	136	2.49	86.6
US H11	C546H3	C36	13,036	40.78	15.98	0.0	0.0	136	2.56	86.1
Mean			14,912	44.40	16.81	1.6	0.1	137	2.66	86.3
LSD (.05)			1,016	2.78	0.58	2.0	NS	NS	0.29	1.4
C.V. (%)			6.9	6.3	3.5	122.6	474.2	8.3	11.00	1.7
F value			3.2**	3.3**	2.9**	3.6**	0.9NS	1.3NS	2.5**	1.7**

[1]/ 6235, 6236, & 6237 (popn-906) are S_1 and FS progenies from MM, S^f, A:aa populations that are similar to C37 x C46 and that segregate for resistance to rhizomania (Rz:rzrz). In 1987, genetic ms (aa) plants from each line were topcrossed to popn-767. These topcrosses were evaluated in tests at Brawley and Salinas in 1988. Popn-767 (6767) is a mm, S^f, A:aa popn improved from the cross C310aa x C546. The original S_1 and FS families were concurrently evaluated and reselected for resistance to rhizomania. The information from these tests will be used to establish an improved MM, S^f, A:aa popn. Also see tests B188, 288, 3088, RZM 188-7, and 388-1 for reactions to bolting, Erwinia, powdery mildew, and rhizomania. Hybrid 7906H68 is a check population hybrid made in the usual direction of mm CMS x MM.

TEST 888. GCA OF MONOGERM, GENETIC MS (aa) LINES WITH C46 OR C92, SALINAS, CA., 1988

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 25, 1988
Harvested: September 19-20, 1988

Variety	Description[1]/		Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity
	Female	Male	Lbs	Tons	%	%	%	No.	%	%
Y652H36	5766-23aa	C92	16,218	46.92	17.29	0.0	0.3	139	2.54	87.1
Y746H65	6766-23aa	C46/2	15,863	45.41	17.42	0.0	0.3	137	2.39	87.9
Y746H115	(776)6233aa	C46/2	15,534	47.06	16.51	0.0	0.9	134	2.34	87.5
Y652H17	(762-17)3212-17aa	C92	15,418	47.06	16.35	0.0	0.6	135	2.16	88.3
Y746H82	(C310/6)6756aa	C46/2	15,350	45.48	16.84	0.0	0.0	143	2.49	87.0
Y746H56	(C309)5816aa	C46/2	15,339	44.01	17.45	0.0	0.0	134	2.53	87.3
Y652H54	5766-62aa	C92	15,183	45.55	16.66	0.0	0.0	143	2.44	87.2
Y746H55	86-309aa	C46/2	15,169	42.80	17.66	0.0	0.0	137	2.36	88.2
Y746H51	6833aa	C46/2	15,161	45.30	16.73	0.0	0.0	136	2.33	87.7
Y652H34	5766-8aa	C92	15,003	45.88	16.33	0.6	0.0	134	2.33	87.5
Y746H88	C790-68aa	C46/2	14,893	44.24	16.81	0.0	0.5	133	2.16	88.5
Y746H76	6776aa	C46/2	14,871	43.13	17.20	0.0	0.0	139	2.26	88.4
Y652H35	5766-14aa	C92	14,793	45.44	16.26	0.0	0.0	134	2.38	87.2
Y746H108	(767 x 566)6224aa	C46/2	14,784	43.88	16.84	0.0	0.0	136	2.35	87.7
Y746H41	5742-24aa	C46/2	14,774	44.81	16.47	0.0	0.2	137	2.21	88.2
Y652H56	(C309)5816aa	C92	14,758	43.87	16.80	0.0	0.0	142	2.62	86.5
Y746H107	(C309)6222,3aa	C46/2	14,722	42.79	17.11	0.0	0.6	141	2.54	87.0
Y746H69	6766-62aa	C46/2	14,705	42.93	17.12	0.0	0.0	134	2.06	89.2
Y746H114	(566)6232aa	C46/2	14,560	43.60	16.75	0.0	0.7	129	2.19	88.3
Rhizosen	Holly(1/5/88)		14,519	43.18	16.74	0.0	0.0	133	2.17	88.5

TEST 888. GCA OF MONOGERM, GENETIC MS (aa) LINES WITH C46 OR C92, SALINAS, CA., 1988
(Continued)

Variety	Description[1]/		Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity
	Female	Male	Lbs	Tons	%	%	%	No.	%	%
Y746H62	6762aa	C46/2	14,488	44.33	16.34	0.0	0.3	128	2.35	87.4
Y746H67	6767aa	C46/2	14,414	42.56	16.91	0.0	0.0	129	2.49	87.2
Y746H86	C790-55aa	C46/2	14,405	42.72	16.81	0.0	0.0	133	2.18	88.5
Y746H52	6834aa	C46/2	14,373	44.17	16.22	0.0	0.0	130	2.09	88.6
Y652H52	5766-44aa	C92	14,347	42.69	16.79	0.0	0.2	141	2.53	86.8
Y746H113	(566 x 776)6231aa	C46/2	14,322	42.78	16.66	0.0	0.0	132	2.28	87.9
T746H112	(566)6230aa	C46/2	14,319	43.11	16.58	0.0	0.0	130	2.45	87.1
Y746H90	(C790)6790Kaa	C46/2	14,280	43.36	16.42	0.0	0.0	139	2.47	86.9
B6625	Betaseed(11/25/85)		13,981	36.55	18.99	0.0	9.4	141	2.44	88.6
USC 4	Union(787685)		13,738	41.75	16.47	0.3	0.3	135	2.38	87.3
US H11	(786442)C546H3	C36	13,488	43.90	15.36	0.0	0.2	141	2.33	86.9
Y652H51	5766-38aa	C92	13,468	41.72	16.13	0.0	1.3	126	2.21	87.9
Mean			14,726	43.84	16.78	0.0	0.5	135	2.35	87.7
LSD (.05)			1,320	3.16	0.69	0.2	1.7	10	NS	NS
C.V. (%)			9.0	7.30	4.20	883.4	353.9	8.0	15.60	2.0
F value			1.7*	3.0**	5.8**	1.8**	6.7**	1.5*	1.3NS	1.1NS

[1]/ 6222-6233 are mm, S^f, A:aa lines that segregate for resistance to rhizomania.

TEST 988. PERFORMANCE OF EXPERIMENTAL HYBRIDS WITH ADVANCED CMS LINES, SALINAS, CA., 1988

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 25, 1988
Harvested: September 20-21, 1988

Variety	Description[1/]			Acre Yield							
				Sugar	Beets	Sucrose	Bolters	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity
	MS	T-O	Male	Lbs	Tons	%	%	%	No.	%	%
Rhizosen	Holly(1/5/88)			15,166	43.97	17.32	0.6	0.5	140	2.71	86.5
HH 41	Holly(41318)			15,142	44.81	16.89	0.6	0.0	144	2.84	85.6
Y731H23	C306	C309	F86-31/6	15,071	44.35	16.97	0.0	0.2	146	2.91	85.3
KW 1132	Betaseed(11/25/85)			14,749	39.72	18.56	0.6	0.5	143	2.73	87.2
Y746H17	R650		C46/2	14,705	43.19	17.00	0.0	0.0	136	2.74	86.1
Y746H66	5766-23		C46/2	14,565	42.36	17.16	0.3	0.0	134	2.81	85.9
Y731H66	5766-23		F86-31/6	14,557	42.46	17.14	0.0	0.2	143	2.96	85.2
R770H26	C309		R70	14,458	40.72	17.76	1.4	0.0	138	3.33	84.2
Y746H23	C306	C309	C46/2	14,257	41.76	17.10	0.0	0.6	144	2.84	85.7
Y746H16	R602		C46/2	14,206	41.17	17.24	0.0	0.0	129	2.87	85.7
Y746H18	R660		C46/2	14,181	42.05	16.84	0.0	0.0	139	2.73	86.0
Y746H21	C718	C309	C46/2	14,083	42.02	16.68	0.0	0.0	141	2.97	84.8
Y746H33	6827		C46/2	14,034	40.91	17.06	0.0	0.0	139	3.12	84.5
B6625	Betaseed(11/25/85)			13,967	35.53	19.65	0.0	2.6	145	3.07	86.4
SS-NB3	Spreckels(3/23/87)			13,926	40.39	17.21	0.0	0.3	135	2.99	85.2
Y746H70	5766-62		C46/2	13,881	41.28	16.83	0.0	0.0	140	2.86	85.4
Y731H70	5766-62		F86-31/6	13,855	40.27	17.18	0.0	0.0	135	2.76	86.1
4625	Betaseed(1/5/87)			13,722	41.38	16.58	0.0	0.0	144	3.05	84.4
Y731H89	C6790-68		F86-31/6	13,673	39.67	17.29	0.0	1.6	135	2.64	86.7
Y746H20	C562	C309	C46/2	13,589	38.79	17.45	0.0	0.0	144	3.17	84.5

TEST 988. PERFORMANCE OF EXPERIMENTAL HYBRIDS WITH ADVANCED CMS LINES, SALINAS, CA., 1988
(Continued)

Variety	Description[1]/			Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity
				Sugar	Beets						
	MS	T-O	Male	Lbs	Tons	%	%	%	No.	%	%
R739H24	C796-22	C309	R639	13,493	38.36	17.58	0.6	0.0	143	3.26	84.3
US H11	C562	C546	C36	13,489	40.91	16.43	0.0	0.0	144	2.73	85.7
7903H24	C796-22	C309	6903	13,436	38.93	17.26	0.0	0.0	140	3.17	84.4
Y746H3	C562		C46/2	13,338	39.53	16.77	0.0	0.0	146	2.66	86.3
Y746H24	C796-22	C309	C46/2	13,331	39.30	16.96	0.0	0.0	140	2.99	84.9
Y746H26	C309		C46/2	13,301	38.29	17.27	0.0	0.0	136	3.22	84.2
Y746H13	C796-22	C546	C46/2	13,201	39.10	16.82	0.0	0.0	134	2.88	85.3
Y746H72	C718		C46/2	13,067	40.71	15.97	0.0	0.5	149	2.71	85.4
Y746H92	C796-22		C46/2	13,064	37.72	17.29	0.0	0.0	137	3.11	84.7
Y746H27	C562	C796-22	C46/2	12,860	37.65	17.00	0.0	0.6	138	3.08	84.6
Y746H8	C562	C546	C46/2	12,805	37.65	16.96	0.0	0.0	147	2.92	85.3
Y746H37	C306		C46/2	12,731	39.23	16.23	0.0	0.0	140	2.79	85.2
Mean				13,872	40.44	17.14	0.1	0.2	140	2.93	85.4
LSD (.05)				1,240	3.19	0.74	0.5	0.9	8	0.32	1.3
C.V. (%)				9.1	8.00	4.38	434.6	373.6	6.5	11.00	1.6
F value				2.4**	3.4**	6.0**	2.5**	2.8**	2.1**	2.8**	2.6**

[1]/R602, R650, R660 are CMS lines that segregate for resistance to rhizomania.

TEST 1288. HYBRID PERFORMANCE OF MULTIGERM GERMPLASM, SALINAS, CA., 1988

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 26, 1988
Harvested: September 22-23, 1988

Variety	Description			Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Rotted	Non Sucrose SS	Raw J. App. Purity
	MS	T-O	Male	Lbs	Tons	%	No.	No.	%	%
Rhizosen	Holly(1/5/88)			16,113	46.85	17.20	0.3	0.1	2.71	86.4
Y731H82	C310/6aa		C31/6	16,064	46.82	17.16	0.0	0.0	2.99	85.1
Y754H82	C310/6aa		C54	15,919	45.85	17.36	0.1	0.5	3.04	85.0
7906H82	C310/6aa		906	15,899	47.41	16.77	0.1	0.1	3.24	83.8
Y749H82	C310/6aa		C49	15,760	45.97	17.12	1.0	0.0	2.89	85.5
7906H82	C309		906	15,693	46.89	16.75	0.2	0.0	3.17	84.0
Y749H26	C309		C49	15,645	45.28	17.25	0.4	0.1	3.17	84.4
Y639H26	C309		C39	15,520	44.97	17.27	0.2	0.0	3.22	84.2
Y754H26	C309		C54	15,511	45.44	17.06	0.0	0.0	3.22	84.0
Y639H8	C562	C546	C39	15,500	45.87	16.89	0.0	0.0	3.08	84.5
7906H8	C562	C546	906	15,447	47.49	16.24	0.0	0.0	3.13	83.8
7903H82	C310/6aa		903	15,392	44.87	17.14	0.0	0.2	3.10	84.7
Y652H8	C562	C546	C92	15,335	46.42	16.55	0.0	0.1	2.95	84.8
Y731H8	C562	C546	C31/6	15,322	47.76	16.03	0.0	0.1	2.99	84.2
T739H26	C309		R39(C2)	15,321	44.00	17.42	0.5	0.1	3.19	84.5
Y731H26	C309		C31/6	15,257	45.47	16.79	0.1	0.1	3.08	84.5
Y746H82	C310/6aa		C46/2	15,251	44.78	17.04	0.0	0.1	3.05	84.8
Y746H26	C309		C46/2	15,224	44.67	17.05	0.0	0.0	3.06	84.7
Y749H8	C562	C546	C49	15,123	44.81	16.87	0.3	0.0	2.96	85.1
7903H26	C309		903	15,100	44.67	16.90	0.0	0.0	3.08	84.5

TEST 1288. HYBRID PERFORMANCE OF MULTIGERM GERMPLASM, SALINAS, CA., 1988
(Continued)

Variety	Description			Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Rotted	Non Sucrose SS	Raw J. App. Purity
	MS	T-O	Male	Lbs	Tons	%	No.	No.	%	%
B6625	Betaseed(11/25/85)			15,068	40.58	18.52	0.0	2.6	3.01	86.0
SS-NB3	Spreckels(3/23/87)			15,033	44.50	16.89	0.0	0.1	2.94	85.1
Y639H82	C310/6aa		C39	14,991	42.62	17.59	0.3	0.0	3.09	85.0
USC 4	Union(11/16/87)			14,891	43.97	16.95	0.0	0.1	3.14	84.3
Y641H8	C562	C546	C91	14,859	44.94	16.52	0.0	0.0	2.86	85.2
Y746H8	C562	C546	C46/2	14,825	45.51	16.27	0.0	0.1	2.96	84.6
Y754H8	C562	C546	C54	14,611	43.80	16.69	0.0	0.2	2.94	85.0
R770H8	C562	C546	R70	14,599	44.41	16.44	1.0	0.0	2.97	84.7
R739H82	C310/6aa	C546	R39(C2)	14,568	42.89	16.97	0.4	0.1	3.17	84.2
7903H8	C562	C546	903	14,470	44.75	16.21	0.0	0.0	3.23	83.4
R739H8	C562	C546	R39(C2)	14,379	44.37	16.20	0.0	0.1	2.92	84.7
US H11	C562	C546	C36	14,211	44.44	15.96	0.0	0.1	2.92	84.5
Mean				15,216	45.10	16.88	0.1	0.1	3.05	84.7
LSD (.05)				965	2.38	0.54	0.3	0.3	0.25	1.1
C.V. (%)				6.4	5.37	3.26	247.5	211.7	8.20	1.4
F value				2.0**	3.1**	7.0**	3.9**	13.4**	2.0**	2.2**

TEST 1388. EXPERIMENTAL HYBRIDS WITH C31/6, SALINAS, CA., 1988

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 26, 1988
Harvested: September 29-30, 1988

Variety	Description[1]/			Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Rotted	Non Sucrose SS	Raw J. App. Purity
	MS	T-O	Male	Lbs	Tons	%	No.	No.	%	%
Y731H105	6222-31aa		C31/6	16,600	47.56	17.46	0.1	0.1	3.06	85.1
Rhizosen	Holly(1/5/88)			16,495	46.73	17.64	0.6	0.0	2.74	86.5
Y731H92	C796-22		C31/6	16,455	48.22	17.04	0.0	0.0	3.20	84.1
Y731H42	5742-24		C31/6	15,946	46.59	17.11	0.0	0.2	3.16	84.4
Y731H66	5766-23		C31/6	15,894	47.63	16.71	0.0	0.0	2.95	84.9
Y731H106	6232-33aa		C31/6	15,735	45.93	17.13	0.0	0.0	3.08	84.7
Y731H89	C790-68		C31/6	15,721	46.64	16.88	0.1	0.2	2.92	85.2
Y731H72	C718		C31/6	15,686	49.31	15.91	0.1	0.1	2.88	84.6
Y631H87	5796-43aa		C31/6	15,661	46.08	17.00	0.0	0.0	2.69	86.3
Y731H70	5766-62		C31/6	15,554	48.10	16.16	0.0	0.0	2.79	85.2
Y731H20	C562	C309	C31/6	15,552	46.74	16.58	0.0	0.0	2.84	85.3
Y731H21	C718	C309	C31/6	15,549	47.49	16.34	0.0	0.1	2.82	85.3
Y731H26	C309		C31/6	15,487	45.28	17.06	0.0	0.0	3.24	83.9
Y731H99	6796-6		C31/6	15,486	46.52	16.64	0.0	0.0	2.92	85.0
Y731H90	C790aa		C31/6	15,436	48.23	15.98	0.0	0.0	2.98	84.2
HH 41	Holly(41318)			15,369	47.19	16.30	0.0	0.0	2.73	85.6
Y731H76	6776aa		C31/6	15,273	46.00	16.61	0.0	0.1	2.99	84.7
Y731H82	C310/6aa		C31/6	15,230	45.85	16.57	0.1	0.0	2.94	84.9
Y731H24	C796-22	C309	C31/6	15,218	45.93	16.54	0.0	0.0	2.97	84.7
Y731H67	6767aa		C31/6	15,132	46.86	16.09	0.1	0.0	3.06	83.9

TEST 1388. EXPERIMENTAL HYBRIDS WITH C31/6, SALINAS, CA., 1988
(Continued)

Variety	Description[1/]			Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Rotted	Non Sucrose SS	Raw J. App. Purity
	MS	T-O	Male	Lbs	Tons	%	No.	No.	%	%
Y731H87	C790-55		C31/6	15,120	46.41	16.26	0.0	0.2	2.86	85.0
Y731H93	C796-22aa		C31/6	15,060	45.97	16.38	0.0	0.0	2.86	85.1
Y631H86	5796-28aa		C31/6	14,866	43.49	17.09	0.0	0.1	2.89	85.5
Y631H56	C309aa		C31/6	14,840	43.70	16.98	0.0	0.0	3.13	84.4
Y631H89	5796-114aa		C31/6	14,759	46.55	15.82	0.1	0.0	3.03	83.9
Y731H8	C562	C546	C31/6	14,753	44.94	16.36	0.1	0.0	3.01	84.4
Y731H96	C796aa		C31/6	14,683	44.97	16.30	0.0	0.0	2.96	84.6
Y731H23	C306	C309	C31/6	14,648	47.22	15.49	0.0	0.1	2.94	84.0
Y631H85	5796-15aa		C31/6	14,587	45.30	16.08	0.0	0.2	2.97	84.3
Y731H37	C306		C31/6	14,566	46.72	15.58	0.0	0.3	3.08	83.4
Y731H13	C796-22	C546	C31/6	14,336	44.81	15.99	0.0	0.0	2.99	84.2
US H11	C562	C546	C36	14,232	44.61	15.95	0.1	0.0	2.87	84.7
Mean				15,310	46.36	16.50	0.0	0.07	2.96	84.7
LSD (.05)				1,153	NS	0.65	0.2	NS	0.29	1.3
C.V. (%)				7.64	3.29	4.0	535.8	416.50	9.90	1.6
F value				2.1**	1.2NS	5.2**	1.5*	1.2NS	1.6*	2.0**

[1/] 6222-31 and 6232-33 = mm, S^f, A:aa popns that segregate for Rz. C310/6, 6767, 6776, C790, & C796 = improved mm, S^f, A:aa popns. 5742-24 from popn-C789/2 by S_1-TX. 5766-23 & -62 from popn-767 by S_2-TX. C790-68 & -55 from popn-C790 by S_1 evaluation per se. C796-22, 6796-6, 5796-15, -28, -43, -114 from popn-C796 by S_1-TX.

TEST 1488. EVALUATION OF EXPERIMENTAL HYBRIDS WITH RHIZOMANIA RESISTANCE WITHOUT RHIZOMANIA, SALINAS, CA., 1988

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 26, 1988
Harvested: October 3-4, 1988

Variety	Description[1]/			Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Rotted	Non Sucrose SS	Raw J. App. Purity
	MS	T-O	Male	Lbs	Tons	%	No.	No.	%	%
7767H101	6235aa		6767	17,523	52.60	16.71	2.1	0.0	3.28	83.6
7906H26	C309		906	17,277	51.68	16.74	0.1	0.0	3.41	83.0
7767H102	6236aa		6767	17,178	52.03	16.48	0.6	0.0	3.04	84.4
7767H103	6237aa		6767	16,997	52.67	16.10	0.6	0.1	3.40	82.5
Y746H16	R502		C46/2	16,936	51.07	16.59	0.0	0.0	2.91	85.0
Y746H26	C309		C46/2	16,588	48.94	16.95	0.0	0.0	2.94	85.1
Rhizosen	Holly(1/5/88)			16,565	49.44	16.73	0.6	0.1	2.73	85.9
USC 4	Union(787685)			16,442	50.65	16.21	0.0	0.0	2.69	85.6
Y746H115	6233aa		C46/2	16,392	49.84	16.46	0.0	0.1	2.92	84.9
7906H106	6232-33aa		906	16,345	50.09	16.31	0.1	0.1	2.95	84.7
7906H8	C562	C546	906	16,260	50.55	16.09	0.1	0.0	3.05	84.0
R739H106	6232-33aa		R39(C2)	16,256	48.06	16.92	0.2	0.1	2.93	85.2
Y746H111	6228-29aa		C46/2	16,246	50.24	16.09	0.1	0.1	3.11	83.7
R739H105	6222-31aa		R39(C2)	16,152	49.04	16.47	0.6	0.0	3.17	83.9
Y746H112	6230aa		C46/2	16,078	48.33	16.64	0.0	0.2	2.71	86.0
7906H105	6222-31aa		906	15,952	48.29	16.51	0.3	0.0	3.05	84.4
Y639H26	C309		C39	15,915	47.36	16.79	0.1	0.1	2.92	85.1
Y746H108	6224aa		C46/2	15,871	47.53	16.70	0.0	0.0	2.92	85.1
Y746H110	6226-27aa		C46/2	15,770	49.33	15.94	0.0	0.2	2.88	84.6
Rizor	SES(1987)			15,755	48.70	16.18	0.0	0.2	3.17	83.6

TEST 1488. EVALUATION OF EXPERIMENTAL HYBRIDS WITH RHIZOMANIA RESISTANCE WITHOUT RHIZOMANIA, SALINAS, CA., 1988
(Continued)

Variety	Description[1]/			Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Rotted	Non Sucrose SS	Raw J. App. Purity
	MS	T-O	Male	Lbs	Tons	%	No.	No.	%	%
Y746H107	6222-23aa		C46/2	15,542	48.74	15.88	0.0	0.0	2.95	84.4
Y639H8	C562	C546	C39	15,454	47.03	16.33	0.0	0.1	2.88	84.9
Y746H8	C562	C546	C46/2	15,420	49.98	15.38	0.0	0.0	3.07	83.3
Y746H109	6225aa		C46/2	15,896	47.15	16.33	0.0	0.1	2.91	84.8
R739H26	C309		R39(C2)	15,346	46.42	16.53	0.3	0.0	3.35	83.1
Y746H114	6232aa		C46/2	15,177	47.44	15.92	0.0	0.0	2.79	85.0
Y746H113	6231aa		C46/2	15,174	47.20	16.08	0.0	0.0	2.96	84.5
R739H8	C562	C546	R39(C2)	14,889	46.25	16.01	0.0	0.0	2.89	84.6
US H11	C562	C546	C36	14,737	48.77	15.06	0.0	0.0	2.94	83.5
R739(C3)			R39(C3)	14,684	44.55	16.43	0.3	0.2	3.18	83.7
(C39)			C39(CO)	14,509	41.67	17.39	0.3	0.0	2.97	85.4
R739(C2)			R39(C2)	12,572	38.41	16.28	0.6	0.0	3.21	83.5
Mean				15,855	48.44	16.35	0.2	0.0	3.01	84.4
LSD (.05)				1,384	3.01	0.75	0.5	NS	0.35	1.6
C. V. (%)				8.8	6.31	4.67	213.0	394.7	12.00	2.0
F value				3.8**	7.4**	2.8**	5.4**	0.9NS	2.1**	2.1**

[1]/ 906 = MM, S^f, A:aa popn that segregates for Rz synthesized from 6235, 6, 7. 6235, 6236, & 6237 = composites of 16 S_1, 11 FS, 7 FS lines that segregate for Rz. 6767 = mm, S^f, A:aa popn used as a tester. 6222-6233 = mm, S^f, A:aa lines that segregate for Rz.

TEST 2388. EVALUATION OF GCA OF MONOGERM AND MULTIGERM GERMPLASM, SALINAS, CA., 1988

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: October 13-14, 1988

Variety	Description[1]/		Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Beets/ 100'	Raw J. App. Purity	Powdery Mildew[2]/
	MS	Male	Lbs	Tons	%	%	No.	%	Rating
Y754H26	86-309CMS	Y654	18,956	54.14	17.51	0.0	136	85.7	4.9
Y731H23	86-309H37	F86-31/6	18,828	56.19	16.75	1.5	129	86.2	4.1
Y749H26	86-309CMS	Y649	18,786	53.67	17.49	0.0	134	85.4	4.6
Y731H90	C790Kaa	F86-31/6	18,611	56.07	16.61	1.6	126	86.8	4.0
Y746H23	86-309H37	Y646	18,551	54.65	16.95	0.6	138	86.6	4.2
Y746H82	C310/6aa	Y646	18,371	53.57	17.11	0.0	133	85.7	3.2
Y746H90	C790Kaa	Y646	18,366	54.74	16.74	0.3	134	86.1	3.9
Y731H82	C310/6aa	F86-31/6	18,362	53.40	17.20	0.3	128	86.4	4.0
HH37	Holly,L37368		18,329	53.74	17.08	1.2	134	87.0	4.4
Y731H67	6767aa	F86-31/6	18,309	54.22	16.88	0.3	130	86.1	3.6
Y639H26	F85-309CMS	Y539	18,291	51.10	17.90	0.3	136	86.4	4.1
Y746H108	6224(767 x 566)aa	Y646	18,169	53.72	16.88	0.0	126	86.3	3.9
Y731H26	86-309CMS	F86-31/6	18,045	51.86	17.43	0.3	136	85.9	4.6
R770H26	86-309CMS	6257-62	17,966	52.45	17.14	0.3	129	85.5	5.1
Rhizosen	Holly,1/5/88		17,888	52.60	17.01	0.6	127	86.8	4.5
Y746H62	6762aa	Y646	17,887	54.31	16.48	0.9	130	86.0	3.8
Y746H109	6225(767 x 776)aa	Y646	17,881	53.10	16.84	1.4	122	86.4	4.0
7903H26	86-309CMS	6903	17,875	51.13	17.48	0.0	134	86.2	5.8
Y746H67	6767aa	Y646	17,842	52.01	17.13	0.0	130	86.2	3.3
KW 1132	Betaseed,11/25/85		17,794	49.98	17.81	4.4	123	87.2	3.5

TEST 2388. EVALUATION OF GCA OF MONOGERM AND MULTIGERM GERMPLASM, SALINAS, CA., 1988
(Continued)

Variety	Description[1]/		Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Beets/ 100'	Raw J. App. Purity	Powdery Mildew[2]/
	MS	Male	Lbs	Tons	%	%	No.	%	Rating
Y731H96	C796aa	F86-31/6	17,762	54.02	16.44	0.9	124	86.6	4.1
Y731H8	F82-546H3	F86-31/6	17,620	53.92	16.36	2.1	128	86.4	4.3
Y746H76	6776aa	Y646	17,571	52.26	16.81	0.3	137	85.6	3.8
Y746H8	F82-546H3	Y646	17,504	53.09	16.52	0.3	132	86.3	4.2
Y746H26	86-309CMS	Y646	17,432	49.86	17.49	0.0	130	85.8	4.6
4625	Betaseed,1/5/87		17,198	53.48	16.09	0.5	132	84.9	4.3
R739H26	86-309CMS	R639(C2)	17,196	48.92	17.58	0.0	134	84.6	4.5
Y731H76	6776aa	F86-31/6	17,163	52.87	16.23	1.3	125	85.4	4.0
Y746H20	86-309H3	Y646	17,031	50.00	17.04	0.0	130	85.0	4.2
7906H26	86-309CMS	6235,6,7	16,891	49.97	16.95	0.0	133	84.1	5.5
US H11	C546H3	C36	16,868	52.24	16.17	0.2	138	85.3	5.9
SS-Z2	Spreckels,1/22/88		16,132	46.04	17.55	0.6	132	85.7	4.4
Mean			17,859	52.60	16.99	0.6	131	85.9	4.3
LSD (.05)			1,193	3.33	0.52	1.2	8.4	1.4	0.6
C.V. (%)			6.8	6.43	3.10	196.5	6.6	1.7	14.6
F value			2.3**	3.2**	6.6**	3.9**	2.0**	1.9**	7.9**

[1]/ 309H37 = C306 x C309, 309H3 = C562 x C309, 546H3 = C562 x C546. 6762, 6767 (767), 776, & C796 = mm, S^f, A:aa popns. 6224,5 = mm, S^f, A:aa segregating for Rz. Y654 = CO of C54. Y649 = C49. Y539 = CO of C39. Y646 = C3 of C46. 6903 = MM, S^f, A:aa popn. 7906 = MM, S^f, A:aa popn segregating for Rz.

[2]/ Plots were treated with Bayleton. PM developed late and scored on 8/29 & 9/12.

TEST 2488. RETEST OF MONOGERM LINES, SALINAS, CA., 1988

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: October 4-7, 1988

Variety	Description[1]/		Acre Yield Sugar	Beets	Sucrose	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity	Powdery Mildew[2]/
	MS	Male	Lbs	Tons	%	%	No.	%	%	Rating
Y652HH34	5766-8aa	Y452Z	18,608	56.42	16.48	0.0	127	2.55	86.5	4.2
Y652H36	5766-23aa	Y452Z	18,251	53.69	17.04	0.0	135	2.76	86.0	4.4
Y731H23	86-309H37	F86-31/6	18,234	55.43	16.46	0.9	132	2.69	85.9	4.6
Y746H51	6833aa	Y646	18,193	55.05	16.53	0.0	128	2.49	86.9	3.9
Y731H89	C790-68HO	F86-31/6	18,045	54.01	16.68	5.8	126	2.33	87.7	4.1
Y746H52	6834aa	Y646	18,006	55.79	16.15	0.6	131	2.44	86.8	3.8
Y746H88	C790-68aa	Y646	18,006	53.80	16.74	1.4	109	2.39	87.5	3.9
Y652H66	5790-92HO	Y452Z	17,959	55.28	16.24	2.6	138	2.53	86.5	4.5
Y652H75-46	5767-46aa	Y452Z	17,941	52.87	16.97	0.3	126	2.63	86.5	4.3
Y652H75-30	5767-30aa	Y452Z	17,911	54.88	16.33	0.0	112	2.79	85.3	4.3
Y731H42	5742-24HO	F86-31/6	17,867	51.54	17.34	0.7	124	2.52	87.3	4.0
Y746H33	6827HO	Y646	17,765	53.06	16.73	0.3	129	2.51	86.9	4.0
Y652H75-44	5767-44aa	Y452Z	17,746	54.23	16.38	0.0	126	2.44	87.0	3.8
Y652H35	5766-14aa	Y452Z	17,729	56.17	15.79	0.0	110	2.59	85.9	4.3
Y731H70	5766-62HO	F86-31/6	17,683	53.10	16.66	1.9	124	2.47	87.0	4.6
Y746H41	5742-24aa	Y646	17,628	52.51	16.81	0.0	121	2.56	86.7	3.8
Y652H75-27	5767-27aa	Y452Z	17,621	54.56	16.15	0.3	134	2.78	85.2	4.2
Y746H70	5766-62HO	Y646	17,586	53.74	16.36	0.0	129	2.47	86.8	4.1
Y746H66	5766-23HO	Y646	17,516	53.71	16.32	0.3	127	2.58	86.3	3.9
Y652H75-20	5767-20aa	Y452Z	17,491	51.45	17.02	0.3	136	2.63	86.6	3.9

TEST 2488. RETEST OF MONOGERM LINES, SALINAS, CA., 1988
(Continued)

Variety	Description[1]/		Acre Sugar	Yield Beets	Sucrose	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity	Powdery Mildew[2]/
	MS	Male	Lbs	Tons	%	%	No.	%	%	Rating
Y652H23	5816H37	Y452Z	17,449	54.04	16.17	0.2	138	2.83	85.1	5.0
Y731H66	5766-23HO	F86-31/6	17,295	53.07	16.32	1.1	141	2.54	86.5	4.2
Y746H23	86-309H37	Y646	17,076	52.15	16.38	0.3	133	2.86	85.1	5.0
Y652H17	3212-17aa	Y452Z	17,034	53.87	15.84	2.6	126	2.44	86.6	4.8
Y652H51	5766-38aa	Y452Z	17,010	50.82	16.73	0.6	113	2.39	87.5	4.3
Y731H99	6796-6HO	F86-31/6	16,991	52.52	16.21	0.7	121	2.54	86.4	4.0
Y652H54	5766-62aa	Y452Z	16,927	50.77	16.67	0.0	143	2.59	86.5	5.0
Y731H87	C790-55HO	F86-31/6	16,884	50.80	16.64	5.0	126	2.39	87.4	4.5
Y746H86	C790-55aa	Y646	16,705	50.61	16.51	1.0	124	2.47	86.9	3.5
Y652H75-47	5767-47aa	Y452Z	16,586	49.76	16.67	1.2	138	2.78	85.6	3.9
US H11	C546H3	C36	16,449	50.56	16.24	0.3	131	2.57	86.3	6.0
Y652H52	5766-44aa	Y452Z	16,435	49.69	16.54	2.6	138	2.60	86.4	4.3
Mean			17,520	53.12	16.50	1.0	128	2.57	86.5	4.3
LSD (.05)			1,210	3.30	0.48	1.8	11	0.29	1.4	0.4
C.V. (%)			7.0	6.22	2.93	185.1	8.9	11.40	1.7	10.1
F value			1.7**	2.6**	3.9**	4.8**	4.6**	1.8**	1.8**	9.7**

[1]/HO = CMS. aa = genetic ms. Y452Z = C92. Y646 = C3 of C46. 309H37 & 5816H37 = C306 x C309. 5766-# are from popn-767 (766) via S_2-TX progeny evaluation. 5767-# are from popn-767 via S_1-TX. 5742-24 is from popn-789/2. 6796-6 is from popn-796. 6827, 6833, & 6834 are from popn-C310. 6790-# are from popn-790 (C2) via S_1 per se. 5790-92 is from popn-790 (C1) via single-seed descent.

[2]/Plots were treated with Bayleton. PM developed late and was scored on 8/29 & 9/12.

TEST 688. PERFORMANCE OF C0:C1:C2:C3:C4 SYNTHETICS OF POPULATION-790, SALINAS, CA., 1988

8 entries x 8 reps, RCB
2-row plots, 30 ft. long

Planted: January 25, 1988
Harvested: September 27, 1988

Variety[1]	Description	Cycle[2]	Acre Yield				Sucrose	
			Sugar		Beets			
			Actual	Change	Actual	Change	Actual	Change
			Lbs	%	Tons	%	%	%
7790L	5790-S_1aa x A	C4 Syn 1	15,772	26.0	46.91	20.7	16.84	4.5
6756	5756Zaa x A	popn-310/6	14,975	19.7	42.83	10.2	17.51	8.7
7790F	1790Daa x A	C2 Syn 2	14,827	18.5	43.70	12.4	16.98	5.4
7776	6776aa x A	popn-776	14,729	17.7	42.79	10.1	17.22	6.9
6790K	4790Kaa x A	C3 Syn 2	14,646	17.0	44.47	14.4	16.47	2.3
7790D	7790Daa x A	C1 Syn 2	14,594	16.6	44.75	15.1	16.33	1.4
7767	6767aa x A	popn-767	14,324	14.5	42.71	9.9	16.75	4.0
7790C	7790DCaa x A	C0 Syn 2	12,515	0.0	38.87	0.0	16.11	0.0
Mean			14,548		43.38		16.78	
LSD(.05)			822	5.6	1.92	4.4	0.70	4.2
C.V.(%)			5.6		4.40		4.10	
F value			10.2**		11.6**		3.6**	

[1]/Varieties are mm, S^f, A:aa populations. Popns-C310 (6756), -776 (7776), & -767 (7767) have been improved by mass selection for resistance to VY, PM, & ERR and for sucrose %, root yield, and conformation. Popn-790 has been improved by S_1 progeny recurrent selection. Popn-790 was derived from composite crosses among 60 MM & mm lines from the Salinas CTR & VYR breeding programs. Following composite crosses in 1969, population was recombined (aa x A) and selected for mm and O-type.
[2]/C# = cycle of S_1 progeny recurrent selection. SYN# = synthesis number where SYN 1 = selected S_1 progeny families recombined aa x A and SYN 2 = SYN 1 recombined aa x A. Cycles 0, 1, 2, & 4 were recombined in 1987. Cycle 3 was recombined in 1986. S_1 families were selected at about a 20% differential for gross sugar yield of S_1 progenies per se where no line with lower % sugar than test mean was selected.

TEST 688. PERFORMANCE OF C0:C1:C2:C3:C4 SYNTHETICS OF POPULATION-790, SALINAS, CA., 1988
(Continued)

8 entries x 8 reps, RCB
2-row plots, 30 ft. long

Planted: January 25, 1988
Harvested: September 27, 1988

Variety	Beets/ 100'	Sodium	Potassium	Amino Nitrogen	Impurity Value[1]/	Recover. Sugar[1]/
	No.	PPM	PPM	PPM		Lbs/Ton
7790L	141	336	1,426	402	8,564	311
6756	147	307	1,502	372	8,371	325
7790F	144	298	1,423	393	8,341	314
7776	144	264	1,545	404	8,635	318
6790K	139	348	1,444	413	8,764	303
7790D	140	347	1,430	481	9,373	298
7767	137	362	1,596	339	8,488	309
7790C	137	422	1,568	403	9,235	294
Mean	141	335	1,492	401	8,721	309
LSD (.05)	NS	90.1	98	71	NS	15.0
C.V. (%)	5.7	26.7	6.5	17.8	9.4	4.8
F value	1.5NS	2.3*	4.2**	2.5*	1.8NS	3.8**

[1]/ Impurity Value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_2-N. Sugar loss per ton of beets = (Impurity Value) (1.5) (0.002).

TEST 2588. PERFORMANCE OF C0:C1:C2:C3:C4 SYNTHETICS OF POPN-790, SALINAS, CA., 1988

8 entries x 8 reps, RCB
2-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: September 28, 1988

Variety	Description	Cycle	Acre Yield					
			Sugar		Beets		Sucrose	
			Actual	Change	Actual	Change	Actual	Change
			Lbs	%	Tons	%	%	%
7790L	5790-S_1aa x A	C4 Syn 1	16,031	25.6	47.43	16.0	16.91	8.3
7790D	7790Daa x A	C1 Syn 2	15,117	18.4	46.89	14.6	16.14	3.4
6756	5756Zaa x A	popn-310/6	15,050	17.9	44.51	8.8	16.89	8.2
7790F	1790Daa x A	C2 Syn 2	14,910	16.8	44.26	8.2	16.82	7.7
6790K	4790Kaa x A	C3 Syn 2	14,905	16.7	45.48	11.2	16.39	5.0
7776	6776aa x A	popn-776	14,755	15.6	45.12	10.3	16.35	4.7
7767	6767aa x A	popn-767	14,484	13.4	43.30	5.9	16.71	7.1
7790C	7790Caa x A	C0 Syn 2	12,769	0.0	40.90	0.0	15.61	0.0
Mean			14,753		44.74		16.48	
LSD(.05)			1,085	7.3	2.62	5.8	0.64	3.9
C.V.(%)			7.3		5.80		3.90	
F value			5.8**		5.0**		3.9**	

TEST 2588. PERFORMANCE OF C0:C1:C2:C3:C4 SYNTHETICS OF POPN-790, SALINAS, CA., 1988
(Continued)

8 entries x 8 reps, RCB
2-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: September 28, 1988

Variety	Beets 100'	Sodium	Potassium	Amino Nitrogen	Impur. Value[1]/	Recover. Sugar[1]/	Mean Powdery Mildew
	No.	PPM	PPM	PPM		Lbs/Ton	
7790L	125	181	1,417	452	8,480	312	5.1
7790D	118	189	1,556	474	9,060	295	5.3
6756	128	138	1,630	395	8,318	312	4.0
7790F	130	135	1,349	441	8,045	312	4.9
6790K	130	158	1,402	414	8,003	303	4.6
7776	121	154	1,491	388	7,957	303	4.6
7767	105	194	1,499	391	8,149	309	4.1
7790C	107	229	1,687	485	9,637	283	5.0
Mean	120	172	1,504	430	8,456	304	4.7
LSD (.05)	10.6	NS	202	NS	NS	14.6	0.5
C.V. (%)	8.8	43.3	13.4	20.3	14.8	4.8	12.0
F value	7.2**	1.5NS	2.6*	1.6NS	1.8NS	4.1**	5.4**

[1]/ Impurity Value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_2-N. Sugar loss per ton of beets = (Impurity Value) (1.5) (0.002).

TEST 1188. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1988

26 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 1, 1988
Harvested: September 26-27, 1988

Code	Variety	Source	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets 100'
			Lbs	Tons	%	%	%	No.
88-4F-17	86-84C25-020	Holly	15,886	45.78	17.34	0.0	0.0	139
88-4F-8	HH-41	"	15,871	47.67	16.63	0.3	1.4	131
88-4F-5	6BC6280	Betaseed	15,842	47.48	16.67	0.6	0.3	134
88-4F-6	4654	"	15,451	46.33	16.66	0.0	0.7	139
88-4F-14	HH-37	Holly	15,389	44.53	17.27	0.0	0.0	129
88-4F-23	4BX8803	Betaseed	15,327	45.61	16.77	0.0	0.7	130
88-4F-18	4757	"	15,236	46.44	16.43	0.0	0.6	133
88-4F-20	Rhizosen	Holly	15,226	44.01	17.29	0.3	0.0	128
Y754H26	C309CMS x C54	USDA	15,171	45.53	16.63	0.0	0.3	136
88-4F-2	USC-4	Union	15,144	45.52	16.61	0.0	0.0	134
88-4F-15	4625	Betaseed	15,025	46.56	16.11	0.0	0.3	136
88-4F-16	Hill-2	Hilleshog-MH	15,005	43.92	17.11	0.0	0.3	127
88-4F-21	86-1459-029	Holly	14,882	43.26	17.21	0.0	0.3	134
88-4F-10	USC-5	Union	14,800	44.51	16.61	0.0	0.0	139
88-4F-22	84C39-033	Holly	14,738	45.21	16.31	0.0	0.0	134
88-4F-7	SS-NB2	Spreckels	14,594	42.80	17.06	0.0	1.0	132
88-4F-24	85N148-08	Holly	14,518	41.37	17.54	0.7	1.0	129
88-4F-9	SS-NB3	Spreckels	14,499	42.82	16.95	0.0	0.3	125
88-4F-3	H84181	"	14,479	44.92	16.06	0.0	0.0	130
88-4F-4	USC-6	Union	14,348	41.75	17.17	0.0	0.0	135

TEST 1188. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1988
(Continued)

Code	Variety	Source	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets 100'
			Lbs	Tons	%	%	%	No.
88-4F-13	SS-Z2	Spreckels	14,347	41.34	17.32	0.0	0.4	121
88-4F-1	86-84C36-012	Holly	14,187	42.02	16.84	0.0	0.0	129
88-4F-25	US H11	Std, Check	14,072	44.39	15.85	0.0	1.2	133
88-4F-12	84C39-027	Holly	13,527	40.45	16.69	0.3	0.3	116
88-4F-19	H85207	Spreckels	13,368	40.38	16.59	0.0	0.0	121
88-4F-11	SS-Z1	Spreckels	13,100	40.31	16.26	0.0	1.1	113
Mean			14,770	44.04	16.77	0.1	0.3	130
LSD (.05)			1,495	3.61	0.71	NS	NS	10.8
C.V. %			10.3	8.30	4.30	525.30	297	8.4
F value			1.9**	2.9**	3.0**	1.5NS	1.1NS	2.8**

TEST 1188. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1988
(Continued)

26 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 1, 1988
Harvested: September 26-27, 1988

Code	Sodium	Potassium	Amino Nitrogen	Impur. Value[1]/	Impur. Index	Recover. Sugar[1]/	Recover. Sugar[1]/	Recover. Sugar[1]/
	PPM	PPM	PPM			Acre	%	Lbs/Ton
88-4F-17	563	1,311	413	9,181	531	14,617	92.0	319
88-4F-8	549	1,359	477	9,855	597	14,462	91.0	303
88-4F-5	575	1,402	434	9,651	583	14,473	91.2	304
88-4F-6	506	1,372	441	9,396	566	14,143	91.5	304
88-4F-14	512	1,251	471	9,402	544	14,132	91.8	317
88-4F-23	665	1,429	506	10,716	642	13,864	90.3	303
88-4F-18	623	1,423	462	10,130	621	13,828	90.6	298
88-4F-20	492	1,291	439	9,130	528	14,024	92.0	318
Y754H26	630	1,398	503	10,487	633	13,740	90.5	301
88-4F-2	633	1,493	495	10,658	645	13,694	90.3	300
88-4F-15	592	1,512	502	10,626	663	13,541	90.0	290
88-4F-16	613	1,500	520	10,841	638	13,575	90.4	309
88-4F-21	573	1,326	460	9,695	563	13,626	91.5	315
88-4F-10	545	1,323	458	9,573	575	13,522	91.3	303
88-4F-22	710	1,319	522	10,748	659	13,281	90.1	293
88-4F-7	383	1,309	520	9,560	558	13,365	91.6	312
88-4F-24	559	1,253	363	8,542	487	13,453	92.6	325
88-4F-9	526	1,386	521	10,259	606	13,182	90.9	308
88-4F-3	840	1,404	419	10,437	656	13,079	90.1	289
88-4F-4	545	1,328	518	10,157	591	13,075	91.1	313

TEST 1188. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1988
(Continued)

Code	Sodium	Potassium	Amino Nitrogen	Impur. Value[1]/	Impur. Index	Recover. Sugar[1]/	Recover. Sugar[1]/	Recover. Sugar[1]/
	PPM	PPM	PPM			Acre	%	Lbs/Ton
88-4F-13	447	1,388	608	10,822	628	13,001	90.5	313
88-4F-1	625	1,337	452	9,832	587	12,954	91.1	307
88-4F-25	589	1,372	559	10,814	686	12,645	89.7	284
88-4F-12	582	1,331	396	9,132	551	12,431	91.7	306
88-4F-19	546	1,391	467	9,836	595	12,171	91.0	302
88-4F-11	730	1,402	548	11,275	697	11,736	89.5	291
Mean	583	1,370	480	10,029	601	13,447	90.9	305
LSD (.05)	137	133	108	1,268	79	1,425	1.1	14
C.V. %	24	9.8	22.8	12.8	13.4	10.7	1.3	4.8
F value	3.4**	2.0**	2.0**	2.3**	3.4**	1.9**	3.4**	3.8**

[1]/ Impurity Value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_2-N.
Sugar loss per ton of beets = (Impurity Value) (1.5) (0.002)

TEST 1788. NONINOCULATED YELLOWS (BYV) EVALUATION OF MONOGERM, S¹ A:aa GERMPLASM, SALINAS, CA., 1988

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft.long

Planted: February 19, 1988
Harvested: November 2, 1988
Not Inoculated[1]/

Variety	Description[3]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot[2]/	Beets/ 100'[2]/	Raw J. App. Purity	Mean Powdery Mildew[2]/[4]/
		Lbs	Tons	%	%	No.	%	Rating
Y754	Inc. Y654(C54)	17,974	50.99	17.60	0.7	113	85.9	2.8
7797	YR-ER-PMR 5797(A,aa)	17,668	51.62	17.11	1.5	128	84.1	3.8
7790L	5790-S_1aa x A(C4,C790)	16,913	50.76	16.70	1.9	133	84.0	4.3
7862	RZM 6225(A,aa)	16,903	49.76	16.96	1.1	121	83.9	4.6
5755	4755aa x A(C310/5)	16,077	45.47	17.66	0.4	125	86.3	2.7
87-309H92	C796-22CMS x C309	16,077	48.51	16.54	0.4	122	82.0	5.4
7852	RZM 6224(A,aa)	16,016	47.01	17.04	0.9	118	83.9	4.5
87-309H37	C306CMS x C309	15,803	47.35	16.69	0.3	130	83.4	4.6
7743	NB 5743(A,aa)(C789/2)	15,493	45.21	17.13	1.0	131	82.7	3.8
7776	6776aa x A	15,472	46.22	16.73	1.0	123	83.6	4.0
7755	NB 5755(A,aa)(C310/5)	15,024	43.75	17.16	0.3	132	83.2	3.8
6756	5756Zaa x A(C310/6)	14,726	42.06	17.50	1.2	128	84.8	2.5
7767	6767aa x A	14,475	43.55	16.56	0.4	120	83.6	2.4
7756	NB 5756Z(A,aa)(C310/6)	14,349	40.44	17.73	0.7	127	84.1	1.8
F82-546H3	C562HO x C546	14,311	45.71	15.65	1.0	105	82.6	4.9
7796	NB 5796(A,aa)(C796)	13,459	41.97	16.04	3.0	109	80.4	4.5
Mean		15,671	46.27	16.92	1.0	122	83.6	3.8
LSD (.05)		1,605	3.91	1.00	NS	10.7	1.9	0.6
C.V. (%)		7.2	5.90	4.20	161.0	9.0	1.7	16.4
F value		5.1**	6.2**	2.7**	1.6NS	4.8**	4.2**	22.6**

[1]/BYV inoculated and loss data are summarized on the following page.
[2]/Means over both virus treatments.
[4]/Plots treated with Bayleton. PM developed late. Mean of ratings over both treatments on 8/18, 9/1, & 9/9.

TEST 1788. BYV INOCULATED YELLOWS EVALUATION OF MONOGERM, S^f A:aa GERMPLASM, SALINAS, CA., 1988

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 19, 1988
Harvested: November 2, 1988
BYV Inoculated: May 3, 1988

Variety	Description[3]/	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Raw J. App. Purity	Mean Yellows
		Lbs/A	%	Tons/A	%	%	%	%	Rating
Y754	Inc. Y654(C54)	13,780	23.0	41.88	17.6	16.42	6.7	84.4	3.1
87-309H92	C796-22CMS x C309	13,070	17.9	41.17	14.7	15.88	3.9	81.8	4.1
7862	RZM 6225(A,aa)	12,786	23.6	39.97	19.3	15.98	5.7	84.8	4.8
7797	YR-ER-PMR 5797(A,aa)	12,534	28.9	39.54	23.3	15.85	7.4	83.2	4.3
6756	5756Zaa x A(C310/6)	12,379	15.3	36.44	12.8	16.99	2.9	84.4	4.5
7790L	5790-S_1aa x A(C4,C790)	12,244	27.3	40.27	20.6	15.23	8.5	83.3	3.7
5755	4755aa x A(C310/5)	12,236	23.6	39.21	13.6	15.61	11.5	81.7	4.2
7852	RZM 6224(A,aa)	12,077	24.2	37.27	20.4	16.19	5.0	84.0	5.3
87-309H37	C306CMS x C309	12,045	23.7	39.09	17.4	15.36	7.7	81.2	4.3
7767	6767aa x A	11,696	17.6	36.77	14.4	15.94	2.9	83.5	4.3
7776	6776aa x A	11,208	27.6	36.19	21.6	15.46	7.6	82.8	4.0
7743	NB 5743(A,aa)(C789/2)	11,008	28.5	34.05	24.3	16.17	5.5	82.4	4.1
7755	NB 5755(A,aa)(C310/5)	10,630	29.1	34.76	20.3	15.24	11.3	82.8	4.4
7796	NB 5796(A,aa)(C796)	10,472	22.1	35.24	16.1	14.86	7.2	82.4	3.9
7756	NB 5756Z(A,aa)(C310/6)	10,224	27.6	31.50	20.8	16.31	7.8	82.6	4.3
F82-546H3	C562HO x C546	9,008	36.6	31.95	29.9	14.10	9.6	83.0	4.8
Mean		11,712	24.8	37.21	19.2	15.72	6.9	83.0	4.3
LSD (.05)		1,416	NS	3.95	NS	0.90	NS	2.1	0.5
C.V. (%)		8.5	35.3	7.40	44.6	4.00	75.2	1.8	8.8
F value for varieties		10.4**	1.4NS	11.6**	1.1NS	5.7**	1.0NS	3.1**	7.0**
F value for virus treatment		98.1**	--	108.1**	--	23.3*	--	2.2NS	--
F value for variety x virus		1.1NS	--	1.1NS	--	1.0NS	--	2.6**	--

[3]/Y654 = MM, OP check. 309H92, 309H37, & 546H3 = F_1 CMS hybrids. aa x A = recombined through genetic ms. (A,aa) = bulk increase of seed from aa & A plants. YR-ER-PMR = selection for resistance to virus yellows (BWYV), Erwinia, & powdery mildew. NB = selection for nonbolting. RZM = selection for resistance to rhizomania.

TEST 1888. NONINOCULATED YELLOWS (BYV) EVALUATION OF MULTIGERM, S^f, A:aa GERMPLASM, SALINAS, CA., 1988

Split-block with 4 replications
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 19, 1988
Harvested: November 1, 1988
Not Inoculated[1]/

Variety	Description[3]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot[2]/	Beets/ 100'	Raw J. App. Purity	Mean Powdery Mildew[2]/[4]/
		Lbs	Tons	%	%	No.		Rating
7906D	6237aa x A	18,571	54.72	16.99	0.0	127	84.6	4.1
Y754	Inc. Y654(C54)	18,330	49.92	18.35	0.0	118	86.0	2.8
5904	4904aa x A	18,123	52.54	17.23	0.0	117	84.8	3.8
7906C	6236aa x A	17,958	53.54	16.79	0.3	118	82.7	3.9
7903	6903aa x A	17,342	49.92	17.38	0.0	127	83.3	3.3
5747	4747aa x A	16,892	52.50	16.09	0.0	120	83.9	4.6
6902	5902aa x A	16,764	49.28	17.01	0.3	117	85.1	2.8
7905	YR-ER-PMR 5905(A,aa)	15,460	46.88	16.49	0.0	121	82.2	4.1
Mean		17,430	51.16	17.04	0.1	121	84.1	3.7
LSD (.05)		1,696	4.65	0.87	NS	NS	NS	0.5
C.V. (%)		6.6	6.20	3.50	552.1	8.1	2.6	12.2
F value		3.2*	2.7*	5.2**	0.8NS	1.5NS	1.4NS	14.3**

[1]/BYV inoculated and % loss data are summarized on the following page.

[2]/Means over both virus treatments.

[3]/MM, S^f, A:aa = multigerm, self-fertile genetic ms facilitated random-mated populations being developed as sources of improved germplasm for plant breeding studies and advanced sources for extraction of parental lines. Specifically, unlike the traditional O.P., MM germplasm, these MM, S^f, A:aa populations permit an extended choice of breeding methods, including S_1 progeny evaluation (for example, see test 788). Y754 = O.P., MM check. 5747 = near S^f, A:aa equivalent of C37. 7903 = near equivalent of C46. 7906 = lines similar to 5747 and 7903 that segregate for Rz. aa x A = recombination through genetic ms. (A,aa) = bulk increase of both fertile and ms plants.

[4]/Plots treated with Bayleton. PM developed late. Mean ratings over both treatments 8/18, 9/1 & 9/9

TEST 1888. BYV INOCULATED YELLOWS EVALUATION OF MULTIGERM, S^{f}, A:aa GERMPLASM, SALINAS, CA., 1988

Split-block with 4 replications
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 19, 1988
Harvested: November 1, 1988
BYV Inoculated: May 3, 1988

Variety	Description[3]/	Sugar Yield		Beet Yield		Sucrose		Raw J. App. Purity	Mean Yellows[5]/
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss		
		Lbs/A	%	Tons/A	%	%	%	%	Rating
7906D	6237aa x A	14,527	21.5	44.72	18.3	16.29	3.7	81.2	3.5
5904	4904aa x A	14,501	19.2	44.96	13.8	16.13	6.4	82.8	3.3
5747	4747aa x A	14,390	14.5	44.99	14.2	16.00	0.6	82.3	3.6
7906C	6236aa x A	14,338	19.9	45.08	15.5	15.91	5.1	82.3	4.1
6902	5902aa x A	13,951	16.8	42.49	13.6	16.40	3.6	83.4	3.6
7903	6903aa x A	13,617	21.3	41.85	16.2	16.27	6.3	82.6	2.7
Y754	Inc. Y654(C54)	13,278	27.4	39.86	20.0	16.67	9.2	85.1	3.8
7905	YR-ER-PMR 5905(A,aa)	12,554	18.7	38.80	17.1	16.17	1.8	83.3	3.7
Mean		13,895	19.9	42.84	16.1	16.23	4.6	82.9	3.5
LSD (.05)		1,049	NS	3.21	NS	0.67	NS	0.0	0.6
C.V. (%)		5.1	32.1	5.10	39.6	2.80	94.3	2.1	10.8
F value for varieties		5.0**	1.4NS	6.1**	0.5NS	5.3**	1.6NS	1.7NS	4.5**
F value for virus treatment		397.6**	--	1.3**	--	23.5*	--	5.5NS	--
F value for variety x virus		1.5NS	--	0.4NS	--	1.8NS	--	1.3NS	--

[3]/See previous page.

[5]/Mean virus yellows scores from 7/1, 7/11, 7/18, & 7/25. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 2088. NONINOCULATED YELLOWS (BYV) EVALUATION OF MULTIGERM, O.P. GERMPLASM, SALINAS, CA., 1988

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: November 1, 1988
Not Inoculated[1]

Variety	Description[3]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot[2]	Beets/ 100'[2]	Raw J. App. Purity	Mean Powdery Mildew[2][4]
		Lbs	Tons	%	%	No.	%	Rating
Y731H67	6767aa x F86-31/6	20,232	58.44	17.30	0.6	131	85.3	2.8
R773	RZM 6261-62(C46/2Rz)	19,384	57.73	16.81	0.8	111	83.7	3.7
Y731	YR-ER-PMR C31/6	19,041	55.69	17.10	0.0	138	85.5	2.1
Y731H76	6776aa x F86-31/6	19,013	54.55	17.44	0.3	133	85.6	3.7
Y747	YR-ER-PMR Y547	18,971	54.08	17.52	0.4	125	84.9	2.8
Y749	Inc. Y649(C49)	18,969	51.36	18.48	0.0	120	84.9	2.2
Y748	YR-ER-PMR Y548	18,811	50.30	18.73	0.4	134	86.8	3.4
R747	RZM R647	18,703	53.33	17.54	0.0	126	86.0	3.5
Y752	NB C92	18,696	52.86	17.66	0.3	124	85.9	2.4
U86-46/2	Inc. C46/2(86342)	18,630	52.86	17.61	0.0	129	84.7	2.8
Y756	YR-ER-PMR Y556	18,610	53.68	17.35	0.0	134	86.5	3.6
R739(C3)	RZM R639	18,497	53.40	17.34	0.3	114	84.4	1.4
R739	Inc. R639#	18,487	51.83	17.86	0.0	114	84.6	1.8
Y754	Inc. Y654(C54)	18,349	51.72	17.76	1.0	123	86.5	2.6
R771	RZM 6259-60(C31/6Rz)	18,326	54.19	16.90	1.1	114	84.2	2.6
Y741	YR-ER-PMR C91	18,214	51.21	17.73	0.3	133	85.1	2.0
F86-92	Inc. C92(86165)	18,179	51.62	17.61	0.0	125	86.1	2.8
R770	Inc. 6257-64Rz	18,002	53.45	16.84	1.1	117	84.5	3.2
F86-31/6	Inc. C31/6(86263)	17,799	49.93	17.83	0.8	120	86.3	2.5
Y739	YR-ER-PMR Y539(C39)	17,751	48.57	18.26	0.6	124	86.2	1.1

TEST 2088. NONINOCULATED YELLOWS (BYV) EVALUATION OF MULTIGERM, O.P. GERMPLASM, SALINAS, CA., 1988
(Continued)

Variety	Description[3]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot[2]	Beets/ 100'[2]	Raw J. App. Purity	Mean Powdery Mildew[2][4]
		Lbs	Tons	%	%	No.	%	Rating
R772	RZM 6257-58(C92Rz)	17,486	52.11	16.76	1.5	112	84.2	4.0
Y746	Inc. C46/3	17,332	49.58	17.49	0.3	133	85.8	2.7
R713	RZM R613(FC+Calif)	17,154	48.40	17.71	0.0	111	84.9	2.8
R774	RZM 6263-64(C37Rz)	16,857	51.97	16.21	0.3	119	84.7	3.6
R720	RZM 6220(FC)	16,764	52.37	16.01	0.7	117	82.8	3.5
R739-6	RZM R639-6	16,615	47.83	17.35	1.1	108	84.1	0.7
U86-37	Inc. C37(86433)	15,605	46.36	16.83	0.3	134	85.4	4.9
786	Inc. 868(US75)	15,230	47.60	16.00	2.4	119	84.6	5.3
R703	RZM R603(Alba)	15,126	45.44	16.64	2.2	109	84.2	4.0
R722	Inc. F_2(SB x B.m.)	15,027	45.59	16.46	1.4	128	82.9	4.2
SP7622-0	SP22-0(L80466)	14,372	41.92	17.11	1.0	121	85.4	3.9
R721	RZM 6241-49	13,047	40.57	16.13	0.0	131	81.9	4.5
Mean		17,603	50.95	17.26	0.6	123	85.0	3.0
LSD (.05)		1,701	4.19	0.94	1.2	12.2	2.4	0.7
C.V. (%)		6.9	5.90	3.90	217.7	10.3	2.0	21.4
F value		7.3**	7.3**	4.1**	2.1**	4.0**	1.7*	19.4**

[1] BYV inoculated and % loss data are summarized on the following page.

[2] Means over both treatments.

[3] YR-ER-PMR = mass selection for resistance to BWYV, Erwinia, & powdery mildew. RZM = mass selection for resistance to rhizomania. Rz = segregates for resistance. NB = selection for bolting resistance.

[4] Plots treated with Bayleton. PM developed late. Mean ratings over both treatments 8/18, 9/1, & 9/9.

TEST 2088. BYV INOCULATED YELLOWS EVALUATION OF MULTIGERM, O.P. GERMPLASM, SALINAS, CA., 1988

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: November 1, 1988
Inoculated BYV: May 3, 1986

Variety	Description[3]/	Sugar Yield		Beet Yield		Sucrose		Raw J. App.	Mean Yellows[5]/
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	Purity	
		Lbs/A	%	Tons/A	%	%	%	%	Rating
Y731H67	6767aa x F86-31/6	16,825	16.2	49.10	15.6	17.14	0.8	86.2	3.5
Y731H76	6776aa x F86-31/6	16,009	15.5	47.55	12.8	16.85	2.9	84.6	3.3
R771	RZM 6259-60(C31/6Rz)	15,673	14.4	47.60	12.2	16.46	2.6	82.7	3.3
Y731	YR-ER-PMR C31/6	15,520	18.3	45.14	18.8	17.19	-0.6	85.3	2.6
F86-31/6	Inc. C31/6(86263)	15,376	13.4	45.95	7.9	16.71	6.2	84.3	2.5
Y749	Inc. Y649(C49)	15,309	19.2	44.77	12.7	17.13	7.3	86.4	2.9
Y741	YR-ER-PMR C91	15,230	15.0	44.85	11.8	16.99	4.0	85.2	2.6
R739(C3)	RZM R639	15,177	18.0	46.45	12.8	16.34	5.5	83.0	3.1
Y754	Inc. Y654(C54)	15,137	17.5	44.89	13.1	16.86	4.8	85.0	3.1
Y747	YR-ER-PMR Y547	15,049	20.5	43.46	19.5	17.33	1.2	86.5	3.6
Y739	YR-ER-PMR Y539(C39)	14,980	15.4	41.23	15.1	18.19	0.4	85.7	3.1
Y748	YR-ER-PMR Y548	14,972	20.2	41.85	16.4	17.89	4.4	87.3	3.0
Y756	YR-ER-PMR Y556	14,340	22.8	42.39	20.8	16.92	2.3	85.4	3.7
R770	Inc. 6257-64Rz	14,072	21.6	44.61	16.5	15.76	6.3	82.3	3.6
R747(C3)	RZM R647	13,959	24.8	43.19	18.4	16.16	7.9	84.4	3.0
Y752	NB C92	13,865	25.6	40.46	23.4	17.14	2.9	84.6	3.0
R739	Inc. R639#	13,769	25.5	42.37	18.1	16.24	9.0	82.7	3.4
R773	RZM 6261-62(C46/2Rz)	13,520	30.0	41.45	28.1	16.33	2.4	83.9	3.6
R772	RZM 6257-58(C92Rz)	13,453	22.7	40.84	21.5	16.48	1.7	84.2	3.8
U86-46/2	Inc. C46/2(86342)	13,282	28.4	39.92	24.3	16.65	5.4	83.2	2.9

TEST 2088. BYV INOCULATED YELLOWS EVALUATION OF MULTIGERM, O.P. GERMPLASM, SALINAS, CA., 1988
(Continued)

Variety	Description[3]/	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Raw J. App. Purity	Mean Yellows[5]/
		Lbs/A	%	Tons/A	%	%	%	%	Rating
R774	RZM 6263-64(C37Rz)	13,150	21.7	40.10	22.7	16.41	-1.3	84.0	3.4
F86-92	Inc. C92(86165)	13,080	28.2	39.16	24.2	16.67	5.4	84.6	2.5
R713	RZM R613	12,698	25.8	37.74	21.9	16.83	5.0	83.2	3.1
Y746	Inc. C46/3	12,698	26.9	38.46	22.5	16.49	5.7	83.6	2.4
U86-37	Inc. C37(86433)	12,386	20.1	38.56	16.4	16.08	4.3	84.0	2.5
R722(C50)	Inc. F_2(SB x B.m.)	11,406	23.5	37.95	16.3	15.02	8.7	81.2	3.0
R739-6	RZM R639-6	10,874	34.4	35.72	25.3	15.21	12.3	82.9	4.1
R720	RZM 6220(FC)	10,573	30.9	35.96	31.3	14.75	8.0	82.1	4.5
R703	RZM R603(Alba)	9,654	36.0	31.70	30.1	15.23	8.4	83.3	5.2
R721	RZM 6241-49	9,164	29.1	31.78	20.7	14.40	10.7	79.3	2.8
786	Inc. 868(US 75)	9,026	40.7	32.83	31.1	13.74	14.1	81.3	4.0
SP7622-0	Sp22-0(L80466)	7,437	48.3	27.04	35.7	13.74	19.6	82.0	5.2
Mean		13,365	24.3	40.78	19.9	16.29	5.6	83.9	3.3
LSD (.05)		1,326	10.3	3.66	19.2	0.74	6.4	2.4	0.5
C.V. (%)		7.1	30.1	6.40	32.8	3.20	81.7	2.1	12.2
F value for varieties		22.3**	5.1**	16.6**	4.0**	13.0**	3.8**	6.1**	11.7**
F value for treatment		822.4**	--	470.6**	--	57.0**	--	77.7**	--
F value for variety x virus		2.5**	--	2.9**	--	3.4**	--	0.8NS	--

[3]/See previous page.

[5]/Mean virus yellows scores from 7/1, 7/11, 7/18, 7/25. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 2188. NONINOCULATED YELLOWS (BYV) REACTION OF EXPERIMENTAL HYBRID COMBINATIONS TO BYV INFECTION, SALINAS, CA., 1988

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: October 17-18, 1988
Not Inoculated[1]/

Variety	Description[3]/	Acre Yield Sugar	Beet	Sucrose	Root Rot[2]/	Beets 100'[2]/	Raw J. App. Purity	Powdery Mildew[2]/[4]/
		Lbs	Tons	%	%	No.	%	Rating
Y731H89	C790-68HO x F86-31/6	19,745	54.27	18.19	1.3	131	85.9	4.1
Y731H90	C790Kaa x F86-31/6	19,601	56.10	17.50	1.0	130	86.1	3.8
Y731H23	86-309H37 x F86- 31/6	19,358	55.28	17.56	0.9	129	84.7	4.0
Y731H70	5766-62HO x F86-31/6	19,358	54.90	17.64	0.4	125	86.6	4.8
Y731H67	6767aa x F86-31/6	19,347	56.35	17.19	0.0	125	83.5	3.6
HH 41	Holly(41318)	19,197	57.23	16.76	0.0	134	84.0	4.7
Y731H37	84-306CMS x F86-31/6	19,126	57.51	16.58	1.3	125	84.5	3.6
Y731H82	C310/6aa x F86-31/6	19,087	53.14	17.96	0.0	130	85.0	4.0
Y754H8	F82-546H3 x Y654(C54)	19,032	54.62	17.45	0.7	129	85.6	4.4
Y731H20	86-309H3 x F86-31/6	18,888	52.53	17.96	0.3	137	85.0	4.5
R770H82	C310/6aa x R70	18,869	54.13	17.42	0.0	132	85.2	4.3
Y731H93	F85-796-22aa x F86-31/6	18,841	53.03	17.79	0.0	114	84.2	4.9
Y731H96	C796aa x F86-31/6	18,790	55.65	16.90	0.7	125	84.5	5.3
Y746H82	C310/6aa x Y646(C46/3)	18,776	53.35	17.60	0.0	138	84.9	3.7
Y731H66	5766-23HO x F86-31/6	18,636	54.83	17.00	0.7	130	84.6	3.7
B6625	Betaseed(11/25/85)	18,615	44.57	20.89	4.8	122	86.2	3.5
Y731H8	F82-546H3 x F86-31/6	18,588	53.47	17.39	0.4	121	84.9	4.6
Y731H87	C790-55HO x F86-31/6	18,546	51.15	18.14	1.3	133	84.9	3.9
7903H82	C310/6aa x 6903	18,494	52.02	17.77	0.0	131	85.6	4.6
Y731H26	86-309CMS x F86-31/6	18,388	51.53	17.85	0.0	127	84.9	5.4

TEST 2188. NONINOCULATED YELLOWS (BYV) REACTION OF EXPERIMENTAL HYBRID COMBINATIONS TO BYV INFECTION, SALINAS, CA., 1988
(Continued)

Variety	Description[3/]	Acre Yield Sugar	Acre Yield Beet	Acre Yield Sucrose	Root Rot[2/]	Beets 100'[2/]	Raw J. App. Purity	Powdery Mildew[2/4/]
		Lbs	Tons	%	%	No.	%	Rating
Y749H82	C310/6aa x Y649(C49)	18,330	50.31	18.20	0.3	127	85.1	3.3
Y754H82	C310/6aa x Y654(C54)	18,253	51.15	17.84	1.3	134	85.7	4.1
Rhizosen	Holly(1/5/88)	18,176	52.67	17.26	0.4	127	87.2	5.4
Y639H82	C310/6aa x Y539(C39)	18,136	51.17	17.73	0.7	129	85.7	3.3
7906H82	C310/6aa x 6235,6,7	18,015	52.93	17.01	0.3	133	84.9	4.6
R739H82	C310/6aa x R639	17,923	48.17	18.63	0.0	130	85.6	3.4
US H11	786442,546H3 x C36	17,821	54.32	16.40	0.0	136	84.7	7.1
4625	Betaseed(1/5/87)	17,630	52.49	16.81	0.0	133	82.5	4.5
Y731H76	6776aa x F86-31/6	17,480	52.85	16.55	0.0	126	84.6	4.0
Y731H24	(C796-22 x C309) x C31/6	17,431	50.77	17.11	0.3	133	85.5	5.1
SS-NB3	Spreckels(1/22/88)	17,266	50.92	16.94	0.6	133	85.6	5.0
Y652H82	C310/6aa x Y452Z(C92)	17,192	48.89	17.56	0.3	132	85.1	3.7
Mean		18,529	52.88	17.55	0.6	129	85.1	4.3
LSD (.05)		NS	4.08	1.12	1.3	8.9	NS	0.8
C.V. (%)		6.4	5.50	4.50	246.5	7.4	1.7	18.3
F value		1.3NS	3.5**	4.2**	3.6**	2.5**	1.5NS	8.9**

[1/] BYV inoculated and % loss data are summarized on the following page.

[2/] Means over both virus treatments.

[3/] 5766-62 & -23 = S_2 derived lines from popn-767. 6767, 6776, & C790K = mm, S^f, A:aa populations. 6903 & 7906 = MM, S^f, A:aa populations. 309H37 = C306 x C309. 309H3 = C562 x C309.

[4/] Plots treated with Bayleton. PM developed late. Mean readings over both treatments 9/1, & 9/12.

TEST 2188. BYV INOCULATED YELLOWS REACTION OF EXPERIMENTAL HYBRID COMBINATIONS TO BYV INFECTION, SALINAS, CA., 1988

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: October 17-18, 1988
Inoculated BYV: May 3, 1988

Variety	Description[3/]	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Raw J. App. Purity	Mean Yellows
		Lbs/A	%	Tons/A	%	%	%	%	Rating
Y731H70	5766-62HO x F86-31/6	17,304	10.5	48.93	11.0	17.71	-0.5	86.18	3.0
Y731H26	86-309CMS x F86-31/6	16,672	8.9	46.94	8.6	17.76	0.5	86.12	3.2
Y731H90	C790Kaa x F86-31/6	16,468	15.8	48.73	12.8	16.89	3.5	84.86	3.4
Y731H24	(C796-22 x C309) x C31/6	16,288	4.8	47.36	6.0	17.20	-0.8	84.32	2.8
Y731H37	84-306CMS x F86-31/6	16,117	15.3	49.55	13.4	16.26	2.0	84.46	3.6
Y749H82	C310/6aa x Y649(C49)	16,036	11.9	45.99	8.5	17.44	3.7	86.10	3.5
Y731H66	5766-23HO x F86-31/6	16,018	13.6	47.42	13.1	16.91	0.3	85.57	3.4
Y731H96	C796aa x F86-31/6	15,826	15.8	48.03	13.7	16.49	2.3	84.75	3.0
Y731H67	6767aa x F86-31/6	15,628	19.0	45.95	18.2	17.02	0.9	85.12	3.2
Y731H93	F85-796-22aa x F86-31/6	15,603	16.5	46.52	11.2	16.81	5.0	84.50	3.5
Y731H8	F82-546H3 x F86-31/6	15,594	16.0	46.22	13.4	16.86	2.9	84.94	3.3
Y731H23	86-309H37 x F86-31/6	15,525	19.7	47.21	13.9	16.42	6.3	83.84	2.7
Y731H89	C790-68HO x F86-31/6	15,437	21.5	45.58	15.9	16.94	6.7	85.75	3.1
Y731H76	6776aa x F86-31/6	15,413	11.3	45.28	13.8	17.01	-2.7	84.26	3.1
Y754H82	C310/6aa x Y654(C54)	15,379	15.4	43.60	14.8	17.63	0.9	85.38	3.3
Y731H87	C790-55HO x F86-31/6	15,374	17.1	45.46	11.0	16.91	6.8	85.13	3.3
7903H82	C310/6aa x F86-31/6	15,285	17.4	42.36	18.6	18.08	-2.0	84.97	3.3
Y731H20	86-309H3 x F86-31/6	15,269	19.0	45.41	13.5	16.84	6.3	85.01	3.2
HH 41	Holly(41318)	15,245	20.2	43.81	23.3	17.40	-3.9	85.18	3.8
Y639H82	C310/6aa x Y539(C39)	15,245	15.9	42.65	16.7	17.88	-0.9	85.29	3.5

TEST 2188. BYV INOCULATED YELLOWS REACTION OF EXPERIMENTAL HYBRID COMBINATIONS TO BYV INFECTION, SALINAS, CA., 1988
(Continued)

Variety	Description[3/]	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Raw J. App. Purity	Mean Yellows
		Lbs/A	%	Tons/A	%	%	%	%	Rating
Y731H82	C310/6aa x F86-31/6	15,239	19.9	43.76	17.4	17.41	3.0	85.36	3.3
Y652H82	C310/6aa x Y452Z(C92)	15,081	11.8	42.69	12.5	17.66	-0.6	85.43	3.2
R739H82	C310/6aa x R639	14,853	17.1	43.46	9.7	17.09	8.2	83.82	3.3
R770H82	C310/6aa x R70	14,655	22.2	42.90	20.7	17.10	1.9	84.92	3.8
7906H82	C310/6aa x 6235,6,7	14,584	19.0	41.63	21.4	17.54	-3.1	84.52	3.6
Y746H82	C310/6aa x Y646(C46/3)	14,363	23.5	42.39	20.5	16.94	3.7	84.73	3.5
Rhizosen	Holly(1/5/88)	14,028	22.9	41.34	21.5	16.92	1.8	85.55	4.5
4625	Beta Seed(1/5/87)	13,782	21.6	43.93	15.6	15.73	6.4	82.01	3.9
Y754H8	F82-546H3 x Y654(C54)	13,601	28.6	42.54	22.0	15.98	8.2	83.17	3.9
SS-NB3	Spreckels(1/22/88)	13,425	21.8	40.51	20.2	16.56	2.1	84.08	3.8
US H11	786442,546H3 x C36	13,034	26.4	41.65	23.1	15.68	4.2	83.18	3.4
B6625	Beta Seed(11/25/85)	11,634	37.5	32.65	26.7	17.71	15.2	84.79	4.8
Mean		15,125	18.1	44.45	15.7	17.02	2.8	84.79	3.4
LSD (.05)		1,434	11.3	3.73	10.2	1.00	7.9	1.92	0.5
C.V. (%)		6.8	44.7	6.00	46.0	4.20	205.2	1.60	10.7
F value for varieties		3.8**	2.3**	7.8**	1.9**	4.5**	2.0**	2.8**	5.4**
F value for virus treatment		611.2**	--	322.4**	--	6.2NS	--	3.5NS	--
F value for variety x virus		2.1**	--	1.7*	--	2.3**	--	0.8NS	--

[3/] See 2188 noninoculated for descriptions.

TEST 2288. NONINOCULATED YELLOWS REACTION OF EXPERIMENTAL HYBRIDS WITH C46/2 TO BYV INFECTION, SALINAS, CA., 1988

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: October 6-7, 1988
Not Inoculated[1]/

Variety	Description[4]/	Acre Yield Sugar	Beets	Sucrose	Root Rot[2]/	Beets/ 100'	Raw J. App. Purity	Mean Powdery Mildew[2]/
		Lbs	Tons	%	%	No.		Rating
Y746H108	6224aa x Y646(C46/3)	18,419	52.33	17.63	0.3	133	87.0	3.9
Y746H76	6776aa x Y646	18,367	53.20	17.30	0.3	141	86.1	4.3
Y746H26	86-309CMS x Y646	17,555	51.46	17.10	0.0	138	86.0	4.9
Y746H90	C790Kaa x Y646	17,375	53.20	16.35	0.3	132	86.3	3.8
Y746H66	5766-23HO x Y646	17,156	52.25	16.44	0.0	137	84.8	3.8
Y746H23	86-309H37 x Y646	17,037	51.79	16.42	0.7	131	86.2	4.3
Y746H109	6225aa x Y646	16,966	54.56	15.55	0.6	132	85.0	3.8
Y746H20	86-309H3 x Y646	16,708	48.85	17.04	0.0	130	86.0	4.6
Y746H33	6827HO x Y646	16,666	50.99	16.33	0.4	127	84.7	3.8
Y746H24	(C796-22 x C309) x Y646	16,607	49.56	16.74	0.0	142	86.4	4.7
Y746H82	C310/6aa x Y646	16,581	50.78	16.30	0.3	132	84.8	3.5
Y746H8	F82-546H3 x Y646	16,567	50.65	16.35	0.0	131	86.5	3.9
Y746H67	6767aa x Y646	16,367	51.79	15.80	0.3	131	85.5	3.7
U746H70	5766-62HO x Y646	16,321	50.72	16.01	0.3	130	85.5	4.3
Y746H62	6762aa x Y646	15,623	51.13	15.31	0.0	133	85.2	3.1
US H11	786442,546H3 x C36	15,594	48.50	16.08	0.0	129	85.9	5.9
Mean		16,869	51.36	16.42	0.2	133	85.7	4.1
LSD (.05)		NS	NS	NS	NS	NS	NS	0.8
C.V. (%)		7.3	5.40	6.00	393.1	7.0	2.0	13.5
F value		1.7NS	1.3NS	1.6NS	0.6NS	1.6NS	0.7NS	6.5**

[1]/BYV inoculated and % loss data are summarized on the following page.
[2]/ Means over both virus treatments.
[4]/6762, 6767, 6776, C790, 6224, & 6225 = mm, S^f, A:aa populations.

TEST 2288. INOCULATED YELLOWS REACTION OF EXPERIMENTAL HYBRIDS WITH C46/2 TO BYV INFECTION, SALINAS, CA., 1988

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 18, 1988
Harvested: October 6-7, 1988
BYV Inoculated: May 3, 1988

Variety	Description[4/]	Sugar Yield Inoc.	Sugar Yield Loss	Beet Yield Inoc.	Beet Yield Loss	Sucrose Inoc.	Sucrose Loss	Raw J. App. Purity	Mean Yellows[3/]
		Lbs/A	%	Tons/A	%	%	%	%	Rating
Y746H67	6767aa x Y646	14,557	11.4	44.87	13.4	16.17	2.4	84.1	3.2
Y746H70	5766-62HO x Y646	14,222	10.7	45.70	9.2	15.56	2.3	84.0	3.0
Y746H76	6776aa x Y646	13,933	24.2	44.40	16.2	15.69	9.1	84.8	2.9
Y746H66	5766-23HO x Y646	13,924	18.3	43.80	15.2	15.95	2.8	84.5	3.6
Y746H24	(C796-22 x C309) x Y646)	13,698	16.9	42.92	13.0	15.99	4.4	84.9	3.3
Y746H90	C790Kaa x Y646	13,633	20.9	43.44	17.6	15.75	3.5	85.6	3.2
Y746H26	86-309CMS x Y646	13,416	23.5	41.58	19.0	16.13	5.2	83.0	2.8
Y746H62	6762aa x Y646	13,413	14.0	42.05	17.4	15.96	-4.3	84.8	3.4
Y746H23	86-309H37 x Y646	13,400	20.2	42.24	17.8	15.84	3.3	83.6	3.1
Y746H109	6225aa x Y646	12,733	24.7	40.31	25.9	15.81	-2.1	84.7	3.4
Y746H82	C310/6aa	12,718	22.8	39.83	21.6	15.86	2.2	85.6	3.1
Y746H33	6827HO x Y646	12,706	23.4	40.78	19.8	15.59	4.4	83.9	3.3
Y746H108	6224aa x Y646(C46/3)	12,582	31.3	40.64	21.9	15.46	12.4	84.5	3.3
Y746H20	86-309H3 x Y646	12,558	22.6	40.38	16.5	15.54	8.2	85.0	3.4
Y746H8	F82-546H3 x Y646	11,777	28.6	38.81	23.3	15.14	7.3	84.6	3.5
US H11	786442,546H3 x C36	10,806	30.9	38.02	21.7	14.16	11.8	82.3	3.1
Mean		13,130	21.5	41.86	18.1	15.66	4.3	84.4	3.2
LSD (.05)		1,931	NS	4.84	NS	NS	10.4	1.9	0.4
C.V. (%)		10.3	44.3	8.10	44.5	5.80	171.1	1.6	10.1
F value for varieties		2.1*	1.7NS	2.1*	1.1NS	1.2NS	1.7NS	0.9NS	1.8NS
F value for treatment		37.5**	--	33.7**	--	23.5*	--	19.2*	--
F value for variety x virus		1.6NS	--	1.0NS	--	1.7NS	--	1.3NS	--

[3/] Mean virus yellows scores from 7/1, 7/11, 7/18 & 7/25. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

[4/] See 2288 noninoculated.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1987-88

USDA-ARS, Irrigated Desert Research Station

Tests were located in 88 beds on the north of block K. Rotation included sugarbeet in 1984-85 and cereals in 1986-87. All fertilizer was applied preplant as 46:0:0 and 11:52:0 for a total of 165 units of nitrogen and 165 units of P_2O_5.

Summary: Arrangement of 1987-88 Tests

Test No.	Entries per Test	No. Reps.	Rows per Plot[1/]	Plot Length (ft)	Harv. Date	Test Design
B188	32	4	1	24	May 18	RCB
B288	32	8	1	24	May 19	RCB
B388	32	8	1	24	May 20	RCB
B488[2/]	20	10	1	40	May 23	RCB
B588	14	10	1	40	May 24	RCB
B688	5	10	1	40	May 20	RCB

[1/] Rows 30" wide.
[2/] Area 5 Coded Variety Trial.

Seedling Date: September 15, 1987; irrigated 9/16-17/87.

Irrigations: Sprinkled 9/16-17, 18; furrowed 10/20, 12/3, 1/11/88, 2/17, 3/15, 4/4, 4/18/88.

Thinned: October 6-7, 1987.

Herbicide: None.

Disease and Insect Control: 9/29/87 and 10/6/87 with Lorsban (aerial) at 2 pts/A; 4/8/88 with Sulfur (aerial) at 40 lbs/A to control powdery mildew.

Remarks: Except for test B488 where 2 sugar samples were harvested, only one sugar sample per plot was run. On this basis, these tests should be viewed as preliminary screening trials to evaluate the adaptation of germplasm to Imperial Valley and for tolerance to lettuce infectious yellows (LIYV). Na, K, and NH_2-N values were determined only for tests B488 and B588.

The incidence and severity of LIYV appeared to be very high. Out of 30 randomly tested plants from B488, all tested highly positive for LIYV by ELISA. Leaf and root symptoms also showed the damaging effects of LIYV; crowns were large and rough, latteral roots had proliferated in the grooves of the roots, and high amounts of soil clung to the beets, resulting in very high root tares. The roots themselves often felt less dense than normal and showed extensive vascular discoloration. By January, the petiole nitrates had fallen well below the commercial standards. At harvest, the brei nitrates were also low. Yet sucrose concentration was not very high in these tests.

Other than LIYV, disease and insect incidence and pressure was relatively low. High populations of green peach aphids occurred in March and April. Mites and Empoasca populations were low at harvest time. Powdery mildew occurred in March and early April but was effectively controlled with sulfur. A black scurf caused by Phoma was again evident on some experimental hybrids, particularly those with C300#'s in their parentage. A small infection center of cyst nematode occurred in replication three of test B588.

Bolting was light. All tests had high stand counts and very few gaps or missing feet of row occurred. The tests were harvested under slightly higher soil moisture conditions than normal for Imperial Valley.

All sugar samples were run through Holly's tare laboratory and Holly's plot harvesting equipment was used. We wish to acknowledge the help of Dave Smith and Mary Pistole from Holly's tare laboratory and Dick Frey and Cliff Brown from the Irrigated Desert Research Station for growing these trials.

TEST B188. PROGENY TEST EVALUATION OF POPULATIONS 767 & 906,
BRAWLEY, CA., 1987-88

32 entries x 4 reps, RCB
1-row plots, 24 ft. long

Planted: September 15, 1987
Harvested: May 18, 1988

Variety	Description[1]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Beets/ 100'	Clean Beets	Brei NO_3-N[2]/
		Lbs	Tons	%	%	No.	%	Rating
Checks								
HH41	Holly 41305 (9/11/86)	8,765	29.85	14.69	0.5	163	91.6	2.2
7906H82	C310/6aa x 6235,6,7	7,272	25.01	14.51	0.6	175	91.4	2.5
7906H8	(C562HO x C546) x 6235,6,7	5,222	18.62	14.03	0.0	172	88.7	3.0
7906H67	6767aa x 6235,6,7	5,086	17.85	14.27	0.0	165	88.4	2.7
Retest of 5767 S_1's from B687								
Y652H75-37	5767-37aa x C92	8,539	26.40	16.22	0.0	117	91.6	2.2
Y652H75-39	5767-39aa x C92	7,428	24.68	15.04	0.0	143	89.4	2.5
Y652H75-11	5767-11aa x C92	7,093	25.32	14.00	1.2	167	87.9	3.0
Y652H75-26	5767-26aa x C92	6,578	21.04	15.61	1.8	157	88.6	2.7
Progeny test of S_1's from MM, S^f popn 906								
7767H102-17	6236-1aa x 6767	7,395	25.83	14.25	1.1	168	89.4	3.2
7767H102-22	6236-6aa x 6767	7,322	24.75	14.80	1.1	166	88.4	2.5
7767H103-30	6237-14aa x 6767	6,894	22.59	15.35	0.0	168	89.7	2.2
7767H102-24	6236-8aa x 6767	6,891	25.51	13.61	0.0	145	88.4	2.7
7767H102-20	6236-4aa x 6767	6,662	23.45	14.20	0.0	159	87.0	2.2
7767H103-34	6237-18aa x 6767	6,396	21.78	14.73	0.0	157	89.2	1.5
7767H102-19	6236-3aa x 6767	5,940	21.39	13.89	0.0	162	90.4	2.7
7767H102-25	6236-9aa x 6767	5,816	20.60	14.09	0.0	169	89.1	2.7
7767H102-21	6236-5aa x 6767	5,811	21.46	13.56	1.1	170	91.2	2.2
7767H103-31	6237-15aa x 6767	5,800	20.92	13.90	0.0	174	84.1	3.0
7767H103-29	6237-13aa x 6767	5,732	21.38	13.42	1.5	164	86.6	3.0
7767H102-23	6236-7aa x 6767	5,713	19.83	14.43	0.0	169	89.3	2.7
7767H102-18	6236-2aa x 6767	5,658	19.23	14.72	0.0	164	90.0	2.7
7767H101-10	6235-17aa x 6767	5,484	19.86	13.78	0.0	167	89.4	3.7
7767H102-27	6236-11aa x 6767	5,475	18.75	14.59	0.6	170	87.6	2.5
7767H101-14	6235-28aa x 6767	5,404	19.14	14.15	0.0	161	89.6	3.5

TEST B188. PROGENY TEST EVALUATION OF POPULATIONS 767 & 906,
BRAWLEY, CA., 1987-88
(Continued)

32 entries x 4 reps, RCB
1-row plots, 24 ft. long

Planted: September 15, 1987
Harvested: May 18, 1988

Variety	Description[1]/	Acre Yield Sugar Beets		Sucrose	Bolters	Beets/ 100'	Clean Beets	Brei NO_3-N[2]/
		Lbs	Tons	%	%	No.	%	Rating
7767H103-32	6237-16aa x 6767	5,364	19.06	14.07	0.5	170	87.4	2.7
7767H102-26	6236-10aa x 6767	5,333	19.58	13.57	0.0	159	89.1	2.7
7767H101-9	6235-16aa x 6767	5,196	19.33	13.45	0.0	162	87.9	3.0
7767H103-28	6237-12aa x 6767	5,021	17.90	14.01	0.0	162	87.7	1.7
7767H103-33	6237-17aa x 6767	4,896	17.17	14.31	0.0	167	86.8	2.5
7767H101-16	6235-34aa x 6767	4,265	16.08	13.14	0.0	154	88.0	3.7
7767H101-3	6235-5aa x 6767	4,235	15.69	13.46	0.0	164	86.3	3.0
7767H101-7	6235-14aa x 6767	4,157	16.13	12.91	0.0	159	83.7	3.0
Mean		6,026	21.13	14.21	0.3	162	88.6	2.7
LSD (.05)		1,134	3.89	0.97	NS	NS	3.3	NS
C.V. (%)		13.4	13.10	4.80	325.6	14.5	2.7	29.3
F value		8.1**	6.1**	4.3**	1.1NS	0.9NS	2.4**	1.5NS

Note: uniform and severe infection with LIYV.

[1]/ 6235, 6236, and 6237 = components of MM, S^f, A:aa population 906. From S_o Aa plants, S_1 progenies were produced. Within these S_1 families, topcrosses were made onto the aa plants with popn-767. Popn-767 (6767) is a mm, S^f, A:aa population derived from popn-C310aa x C546.

[2]/ NO_3-N values by Holly's scale where 1 = 1.8, 2 = 3.5, 3 = 6.9 PPM in brei.

TEST B288. RETEST OF EXPERIMENTAL MONOGERM BREEDING LINES,
BRAWLEY, CA., 1987-88

32 entries x 8 reps, RCB
1-row plots, 24 ft. long

Planted: September 15, 1987
Harvested: May 18-19, 1988

Variety	Description[1]	Acre Yield[2] Sugar	Acre Yield[2] Beets	Sucrose[3]	Bolters	Beets/ 100'	Clean Beets	Brei NO_3N[4]
		Lbs	Tons	%	%	No.	%	Rating
Y746H34	6830HO x C46/3	9,427	29.80	15.83	0.0	190	91.3	3.1
HH41	Holly Lot 41305	9,287	29.59	15.68	0.2	190	92.8	2.8
Y731H23	(C306CMS x C309) x F86-31/6	8,916	29.34	15.20	1.7	179	92.8	3.5
Y746H33	6827HO x C46/3	8,807	27.76	15.86	0.0	186	91.1	2.8
Y652H17	3212-17aa x C92	8,748	28.78	15.18	0.2	178	91.9	3.1
Y746H37	C306CMS x C46/3	8,669	29.54	14.69	0.0	178	89.6	3.1
Y731H66	5766-23HO x F86-31/6	8,421	27.26	15.45	0.0	177	92.3	3.1
Y746H51	6833aa x C46/3	8,310	27.01	15.41	0.0	181	89.4	3.2
Y652H58	5821aa x C92	8,258	26.02	15.88	0.0	177	90.4	2.6
Y746H23	(C306CMS x C309) x C46/3	8,182	27.52	14.85	0.0	186	88.2	2.7
Y746H26	C309CMS x C46/3	7,937	25.04	15.85	0.0	187	89.5	2.6
Y746H66	5766-23HO x C46/3	7,894	25.47	15.51	0.0	182	90.7	2.8
7906H26	C309CMS x 6235,6,7	7,841	25.83	15.17	0.0	184	89.4	2.7
Y731H53	6834HO x F86-31/6	7,738	24.67	15.69	0.0	169	94.1	2.7
Y731H99	6796-6HO x F86-31/6	7,634	24.67	15.48	0.0	176	91.0	3.2
Y731H89	C790-68HO x F86-31/6	7,473	23.81	15.68	1.2	165	90.8	3.1
Y731H87	C790-55HO x F86-31/6	7,398	24.16	15.32	0.5	181	88.6	3.2
7903H26	C309CMS x 6903	7,355	23.79	15.47	2.0	174	90.7	2.6
Y631H87	5796-43aa x C31/6	7,349	24.25	15.15	0.6	167	89.8	3.1
Y652H66	5790-SSD-92HO x C92	7,337	24.50	14.98	3.4	175	90.1	2.8

TEST B288. RETEST OF EXPERIMENTAL MONOGERM BREEDING LINES, BRAWLEY, CA., 1987-88
(Continued)

Variety	Description[1]/	Acre Yield[2]/ Sugar	Acre Yield[2]/ Beets	Sucrose[3]/	Bolters	Beets/ 100'	Clean Beets	Brei NO_3 N[4]/
		Lbs	Tons	%	%	No.	%	Rating
Y746H52	6834aa x C46/3	7,277	25.03	14.53	0.0	167	88.2	3.2
Y746H65	5766-23aa x C46/3	7,266	23.22	15.64	0.0	187	87.5	3.1
Y746H86	C790-55aa x C46/3	7,174	23.87	15.02	0.0	169	84.5	3.1
Y746H73	6755-63aa x C46/3	7,157	24.24	14.76	0.0	165	85.0	2.7
Y746H88	C790-68aa x C46/3	7,135	22.92	15.58	0.0	150	86.9	3.1
Y746H74	6755-75aa x C46/3	7,117	23.96	14.91	0.0	166	85.1	2.8
Y731H92	F85-796-22CMS x F86-31/6	6,923	22.92	15.11	0.0	174	90.6	2.7
Y631H85	5796-15aa x C31/6	6,860	22.02	15.56	0.0	161	89.9	3.1
Y746H71	2216-46aa x C46/3	6,843	22.72	15.06	0.0	181	86.1	3.1
US H11	(C562HO x C546) x C36	6,559	22.66	14.46	0.6	179	86.3	3.2
Y631H86	5796-28aa x C31/6	6,345	21.23	14.94	0.0	157	87.9	2.8
Y746H75	6755-136aa x C46/3	5,733	20.31	14.10	0.0	164	85.8	3.1
Mean		7,668	25.12	15.25	0.3	175	89.3	3.0
LSD (.05)		573	1.66	0.55	0.8	15	2.1	NS
C. V. (%)		7.6	6.73	3.70	263.5	8.9	2.4	23.5
F value		17.5**	17.9**	5.1**	5.9**	3.3**	10.3**	0.8NS

Note: Severe and uniform infection with LIYV.

1/ C46/3 = nonreleased reselection from C46/2. 6903 and 906 (6235,6,7) = MM, S^f, A:aa popns. 6830, 6827, 5821, 6755-#'s = S_1's or lines advanced from S_1's extracted from popn-C310. 6212-17 from popn-762. 5766-23 and 2216-46 from popn-767. 6796-#'s from popn-C796. 5790-92 from popn-C790 by SSD. 6833 from C303aa x C309. 6834 from C309aa x C562. HO = CMS. aa = genetics male sterility.

2/ Yield adjusted to clean weight basis. Tare = both soil and crown tare.

3/ One sugar sample per plot.

4/ NO_3-N values by Holly's scale where 1 = 1.8, 2 = 3.5, 3 = 6.9 ppm in brei.

TEST B388. GCA OF MONOGERM GERMPLASM, BRAWLEY, CA., 1987-88

32 entries x 8 reps, RCB
1-row plots, 24 ft. long

Planted: September 15, 1987
Harvested: May 19-20, 1988

Variety	Description[1]	Acre Yield[2] Sugar	Beets	Sucrose[3]	Bolters	Beets/ 100	Clean Beets	Brei[4] NO_3-N
		Lbs	Tons	%	%	No.	%	Rating
HH41	Holly (41305)	9,505	29.85	15.92	0.3	183	90.4	2.7
Y746H112	6230aa x Y646	8,987	27.56	16.33	0.3	160	90.4	2.6
Y731H23	(C306CMS x C309) x Y646	8,861	28.55	15.53	1.4	180	91.2	3.0
HH37	Holly (Rec'd 8/87)	8,678	26.86	16.15	0.5	184	93.5	3.0
Y746H16	R702CMS x Y646	8,640	27.19	15.92	0.0	166	92.4	3.2
Y746H111	6228,9aa x Y646	8,593	26.46	16.24	0.0	162	90.4	2.7
Y731H37	C306CMS x F86-31/6	8,396	28.16	14.90	1.1	177	89.0	3.1
Y731H21	(C718CMS x C309) x Y646	8,317	26.94	15.44	0.2	170	92.2	3.1
Y746H56	C309aa x Y646	8,280	25.90	15.98	0.0	177	88.4	2.8
Y746H26	C309CMS x Y646	8,262	25.80	15.99	0.0	163	88.6	2.5
Y746H37	C306CMS x Y646	8,256	27.45	15.03	0.0	178	85.3	3.3
Y746H107	6222,3aa x Y646	8,248	25.73	16.02	0.0	185	90.5	2.8
Y746H23	(C306CMS x C309) x Y646	8,210	26.53	15.48	0.0	189	89.5	2.8
Y746H76	6776aa x Y646	8,099	25.40	15.95	0.0	177	89.2	2.8
Y746H82	C310/6aa x Y646	8,094	24.68	16.41	0.0	166	87.2	2.7
Y731H66	5766-23HO x F86-31/6	8,088	25.79	15.69	0.0	166	92.6	3.1
Y746H21	(C718CMS x C309) x Y646	8,085	26.02	15.55	0.0	169	89.0	2.7
Y746H66	5766-23HO x Y646	7,877	25.29	15.57	0.0	181	90.5	3.1
Y746H108	6224aa x Y646	7,814	25.67	15.21	0.0	168	89.3	2.7
Y746H72	C718HO x Y646	7,485	24.24	15.42	0.0	156	90.0	2.7

TEST B388. GCA OF MONOGERM GERMPLASM, BRAWLEY, CA., 1987-88
(Continued)

Variety	Description[1]	Acre Yield[2] Sugar	Acre Yield[2] Beets	Sucrose[3]	Bolters	Beets/ 100	Clean Beets	Brei[4] NO_3-N
		Lbs	Tons	%	%	No.	%	Rating
Y731H89	C790-68HO x Y646	7,384	23.58	15.66	0.3	169	89.3	2.6
Y746H20	(C562HO x C309) x Y646	7,349	23.59	15.59	0.0	178	87.7	2.5
Y746H62	6762aa x Y646	7,253	23.36	15.53	0.0	153	87.7	2.7
Y746H24	(C796-22CMS x C309) x Y646	7,160	23.23	15.41	0.0	186	88.4	3.2
Y731H92	F85-796-22CMS x Y646	7,024	22.64	15.52	0.3	170	90.2	2.6
Y746H110	6226,7aa x Y646	7,018	22.89	15.34	0.2	162	85.3	2.8
Y746H3	F82-562HO x Y646	6,930	22.08	15.72	0.0	169	88.9	2.6
Y746H67	6767aa x Y646	6,869	22.42	15.31	0.0	167	85.6	2.6
US H11	(C562HO x C546) x C36	6,802	23.00	14.80	0.3	188	88.3	3.0
Y746H90	C790Kaa x Y646	6,727	21.93	15.33	0.3	170	84.8	2.7
Y746H8	(C562HO x C546) x Y646	6,493	21.24	15.28	0.0	175	86.6	2.7
KW 1132	% S Check (11/25/85)	4,732	14.28	16.54	1.5	174	86.3	2.5
Mean		7,766	24.82	15.65	0.2	173	89.0	2.8
LSD (.05)		561	1.50	0.53	0.7	15.2	2.1	NS
C. V. (%)		7.5	6.30	3.42	361.5	8.9	2.4	22.5
F value		21.3**	27.1**	5.0**	2.1**	3.0**	8.3**	1.1NS

Note: Uniform and severe infection with LIYV.

[1]/ Y646 = C46/3 = reselected C46/2. HO = CMS. aa = genetic male sterility. C310/6, 6762, 6767, 6776, and C790K = mm, S^f, aa populations. 5766-23 from popn-767. 6222-6230 = mm S^f, A:aa popns that segregate for R_z:$r_z r_z$. R702CMS = $R_z R_z$CMS.

[2]/[3]/[4]/ See Test B288.

TEST B588. GCA OF MULTIGERM GERMPLASM, BRAWLEY, CA., 1987-88

14 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 15, 1987
Harvested: May 24, 1988

Variety	Description[1]/	Acre Yield[2]/ Sugar	Acre Yield[2]/ Beets	Sucrose	Bolters	Beets/ 100'	Clean Beets
		Lbs	Tons	%	%	No.	%
HH 41	Holly (41305)	9,320	29.11	16.02	0.1	188	93.1
Y746H37	C306CMS x Y646 (C46/3)	8,899	28.42	15.65	0.0	182	88.7
Y746H23	(C306CMS x C309) x Y646 (C46/3)	8,871	28.33	15.66	0.1	188	89.8
Y652H82	C310/6aa x Y452Z (C92)	8,641	26.50	16.31	2.3	172	91.5
Y731H82	C310/6aa x F86-31/6	8,592	26.01	16.51	0.1	179	93.7
Y746H82	C310/6aa x Y646 (C46/3)	8,362	25.44	16.46	0.1	172	90.7
Y641H82	C310/6aa x Y541 (C91)	8,203	25.08	16.40	0.5	175	91.3
7903H82	C310/6aa x 6903	8,040	24.21	16.60	0.5	185	90.3
R739H82	C310/6aa x R639	7,861	24.09	16.33	0.9	181	90.5
Y749H82	C310/6aa x Y649 (C49)	7,666	23.86	16.07	0.2	171	90.7
7906H82	C310/6aa x 6235,6,7	7,322	22.57	16.22	1.3	187	92.5
Y754H82	C310/6aa x Y654 (C54)	7,147	21.85	16.35	0.2	178	87.9
US H11	(C562HO x C546) x C36	7,057	23.02	15.32	0.5	183	89.1
R770H82	C310/6aa x 6257-64	7,004	22.69	15.45	4.1	178	90.3
Mean		8,070	25.08	16.10	0.8	180	90.7
LSD (.05)		486	1.41	0.49	1.0	NS	1.9
C. V. (%)		6	6.40	3.50	138.3	10.3	2.4
F value		18.8**	21.5**	5.5**	10.3**	1.0NS	5.4**

Note: Severe and uniform infection with LIYV.

TEST B588. GCA OF MULTIGERM GERMPLASM, BRAWLEY, CA., 1987-88
(Continued)

14 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 15, 1987
Harvested: May 24, 1988

Variety	Brei NO_3-N[3]/	Na	K	NH_4-N	Impur. Value[4]/	Impur. Index	Recover. Sugar	Recover. Sugar[4]/
	Rating	PPM	PPM	PPM			%	Lbs/Ton
HH41	1.9	357	2,011	289	9,029	565	91.5	293
Y746H37	2.2	367	2,388	275	9,876	634	90.4	283
Y746H23	2.2	393	2,275	341	10,310	662	90.0	282
Y652H82	1.7	386	2,166	263	9,271	570	91.4	298
Y731H82	2.0	394	2,159	291	9,633	584	91.2	301
Y746H82	1.9	346	2,103	293	9,257	566	91.5	301
Y641H82	2.0	375	2,321	283	9,813	600	90.9	298
7903H82	1.6	368	2,314	313	10,057	609	90.8	301
R739H82	1.8	337	2,370	350	10,440	639	90.4	295
Y749H82	2.1	360	2,336	279	9,754	608	90.8	292
7906H82	2.4	360	2,373	307	10,113	626	90.6	294
Y754H82	1.7	372	2,246	316	9,928	607	90.8	297
US H11	2.4	366	2,363	373	10,740	702	89.4	274
R770H82	2.1	419	2,340	294	10,118	662	90.0	278
Mean	2.0	371	2,259	303	9,837	614	90.7	292
LSD (.05)	NS	NS	174	51.6	919	67	1.0	11.2
C. V. (%)	56.7	24.2	8.7	19.2	10.6	12.5	1.3	4.3
F value	0.5NS	0.6NS	4.4**	3.1**	2.6**	3.3**	3.3**	5.3**

1/ Y646 (C46/3) = nonreleased reselection from C46/2. 6903, 7906 (6235,6,7) = MM, S^f, A:aa populations.

2/ Yield adjusted to a clean weight basis. Tare = both soil and crown tare.

3/ NO_3-N values by Holly's scale where 1 = 1.8, 2 = 3.5, 3 = 6.9,..., 9 =400 ppm NO_3-N in brei.

4/ Extractable sugar based upon impurity value where impurity value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_4-N. Sugar loss per ton of beets = (Impurity value) (1.5) (0.002).

TEST B688. PERFORMANCE OF CO:C1:C2:C3:C4: SYNTHETICS
OF POP-790, BRAWLEY, CA., 1987-88

5 entries x 10 replications, RCB
1-row plots, 40 ft. long

Planted: September 15, 1987
Harvested: May 20, 1988

Variety	Description[1]/	Cycle	Acre Yield				Sucrose	
			Sugar		Beets			
			Actual	Change	Actual	Change	Actual	Change
			Lbs	%	Tons	%	%	%
7790L	5790-S_1aa x A	C4,Syn 1	6,321	12.3	20.88	8.5	15.15	3.6
7790D	7790Daa x A	C1,Syn 2	6,290	11.8	21.79	13.2	14.49	-0.9
6790K	4790Kaa x A	C3,Syn 2	5,971	6.1	19.63	2.0	15.22	4.1
7790C	7790Caa x A	C0,Syn 2	5,628	0.0	19.24	0.0	14.62	0.0
7790F	1790Daa x A	C2,Syn 2	5,517	-2.0	18.14	-5.7	15.22	4.1
Mean			5,945		19.94		14.94	
LSD (0.05)			482	8.1	1.42	7.1	NS	NS
C.V. (%)			9.3		7.90		5.70	
F value			4.8**		8.3**		1.7NS	

Note: Uniform and severe LIYV infection.

1/ Popn-790 = mm, S^f, A:aa population used to evaluate S_1 progeny recurrent selection. S_1 families from selfed S_0 plants were evaluated at Salinas. On the basis of per se performance for sugar yield, the selected S_1 lines were recombined. Because of differentiated age of seed lots, the C0 through C2 synthetics were increased (synthesis 2) in 1987.

TEST B688. PERFORMANCE OF CO:C1:C2:C3:C4: SYNTHETICS
OF POP-790, BRAWLEY, CA., 1987-88
(Continued)

Variety	Bolters	Beets 100'	Clean Beets	Brei NO_3-N[2/]
	%	No.	%	Rating
7790L	0.1	158	89.6	3.6
7790D	1.7	161	90.0	3.6
6790K	0.3	154	88.0	3.5
7790C	1.0	152	90.6	3.7
7790F	3.6	155	88.8	3.4
Mean	1.3	156	89.4	3.5
LSD (0.05)	1.5	NS	1.7	NS
C.V. (%)	122.1	13.5	2.3	18.7
F value	6.9**	0.3NS	2.8*	0.3NS

[2/] NO_3-N values by Holly's scale where 1 = 1.8, 2 = 3.5, 3 = 6.9 ppm in brei.

TEST B488. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA. 1987-88

20 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 15, 1987
Harvested: May 23-24, 1988

Code	Variety	Source	Acre Yield[1]/ Sugar	Acre Yield[1]/ Beets	Sucrose	Bolters	Beets/ 100'	Clean Beets
			Lbs	Tons	%	%	No.	%
5-88-18	86 84C80-019	Holly	9,679	29.54	16.38	0.4	173	93.7
5-88-16	HH41	Holly	9,641	29.67	16.27	0.5	198	93.4
5-88-17	85C5909	Holly	9,556	29.40	16.25	0.0	173	92.8
5-88-2	86 84C26-08	Holly	9,200	27.54	16.70	1.1	173	93.2
5-88-9	HH37	Holly	9,055	27.75	16.32	0.5	182	93.5
5-88-19	86 1459-029	Holly	8,940	27.10	16.50	0.4	180	91.8
5-88-5	85C2408	Holly	8,843	27.24	16.24	0.7	157	92.7
5-88-3	USC-4	Union	8,564	26.88	15.95	0.7	186	89.3
5-88-8	HH46	Holly	8,553	25.90	16.53	0.2	177	91.8
5-88-14	84C39-033	Holly	8,349	25.42	16.43	0.6	167	91.7
5-88-6	SS-NB3	Spreckels	8,088	24.37	16.59	0.2	179	93.0
5-88-11	6BG6155	Betaseed	7,947	24.54	16.19	0.4	191	88.2
5-88-4	6BG6151	Betaseed	7,853	24.38	16.11	0.2	193	90.4
5-88-1	USC-5	Union	7,795	24.06	16.23	0.7	171	89.9
5-88-10	SS-NB2	Spreckels	7,509	22.65	16.57	0.0	180	91.5
5-88-7	Hill-2	MH-Hilleshog	7,093	22.12	16.02	0.3	182	88.8
5-88-20	US H11	Check	6,970	22.72	15.34	0.0	187	88.4
5-88-15	USC-1	Union	6,681	21.26	15.74	0.0	186	89.1
5-88-13	3X8813	Betaseed	6,517	21.23	15.37	0.2	175	84.0
5-88-12	4BX8803	Betaseed	5,584	17.94	15.58	1.1	167	83.5
Mean			8,121	25.09	16.17	0.4	179	90.5
LSD (.05)			442	1.31	0.43	NS	13	1.4
C. V. (%)			6.2	5.90	3.00	217.9	8.3	1.8
F value			51.2**	45.0**	6.5**	1.3NS	4.4**	33.1**

Note: Uniform and severe infection with lettuce infectious yellows virus (LIYV).
[1]/Yield adjusted to a clean weight basis. Tare = both soil and crown tare.

TEST B488. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA. 1987-88
(Continued)

20 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 15, 1987
Harvested: May 23-24, 1988

Variety	Brei NO_3-N[2]/	Na	K	NH_4-N	Impur. Value[3]/	Impur. Index.	Recover. Sugar	Recover. Sugar[3]/
	Rating	PPM	PPM	PPM			%	Lbs/Ton
86 84C80-019	2.1	282	2,088	376	9,784	598	91.0	298
HH41	1.9	264	1,985	293	8,678	536	91.9	299
85C5909	2.6	281	2,183	318	9,468	583	91.2	296
86 84C26-08	2.0	265	1,870	340	8,841	529	92.0	307
HH37	2.4	228	1,987	374	9,323	572	91.4	298
86 1459-029	2.3	259	2,034	315	8,990	546	91.8	302
85C2408	1.8	228	2,248	323	9,492	585	91.2	296
USC-4	2.3	278	2,223	329	9,669	608	90.8	290
HH46	1.9	233	1,937	328	8,781	532	92.0	304
84C39-033	2.4	266	2,012	315	8,958	547	91.7	301
SS-NB3	2.2	214	1,983	401	9,529	574	91.3	303
6BG6155	2.1	275	2,217	332	9,667	598	91.0	294
6BG6151	1.8	258	2,131	392	9,959	619	90.7	292
USC-5	2.1	224	2,118	382	9,714	600	90.9	295
SS-NB2	2.2	196	2,063	454	10,163	614	90.7	300
Hill-2	2.5	333	2,063	351	9,664	605	90.9	291
US H11	2.7	256	2,255	389	10,236	671	89.9	275
USC-1	2.1	232	2,275	368	9,998	639	90.4	284
3X8813	2.5	312	2,235	294	9,481	619	90.7	278
4BX8803	2.3	316	2,169	282	9,215	594	91.0	283
Mean	2.2	260	2,104	348	9,481	588	91.1	294
LSD (.05)	0.5	38	111	50.3	682	51	0.7	9.5
C. V. (%)	27.4	16.7	6.0	16.4	8.2	9.8	1.0	3.7
F value	1.7*	6.6**	8.9**	5.8**	3.5**	4.2**	4.2*	6.3**

[2]/ NO_3-N values by Holly's scale where 1 = 1.8, 2 = 3.5, 3 = 6.9 ppm in brei.

[3]/ Impurity value = 3.5 ppm Na + 2.5 ppmK + 9.5 ppmNH_4-N. Sugar loss per ton of beets = (Impurity value) (1.5) (0.002).

BOLTING EVALUATION AND OBSERVATION, SALINAS, CA., 1988

Full length rows 540 ft. long Planted: November 25, 1987

Variety	Description	No. Roots	Bolting[1] 6/9	Bolting[1] 8/22	P.M.[2] Rating
			%	%	Avg.
USC-1	(787075)	3054	0.1	4.1	3.3
U86-37	(86443)	815	0.0	4.8	4.7
U86-46/2	(86342)	800	0.0	3.9	2.0
Y746	Inc. Y646(C46/3)	675	0.0	0.4	1.0
Y749	Inc. Y649(C49)	736	5.4	37.0	2.3
Y754	Inc. Y654(C54)	677	1.0	9.3	3.3
R739	Inc. R639	684	3.4	38.2	1.0
7903	6903aa x A	1306	0.2	4.5	4.0
7905	YR-ER-PMR 5905(A,aa)	668	0.3	5.2	4.0
7906B,C,D	6235,36,37aa x A	723	4.0	31.0	5.0
F86-31/6	(86263),C31/6	700	0.4	7.0	4.0
Y731	YR-ER-PMR Y531(C31/6)	700	0.0	6.4	3.0
7767	Inc. 6767aa x A	585	13.5	13.5	4.0
87-309	(87672),C309	748	1.1	1.1	7.0
87-309CMS	(87670),C309CMS	732	1.1	9.4	7.7
87-309H3	(87671),C562 x C309	745	1.1	13.0	5.0
87-309H37	(87242),C306 x C309	762	0.0	2.0	3.3
USC-4	(787685)	727	0.1	5.5	4.0
USC-5	(787686)	683	0.0	3.2	4.0
USC-6	(787687)	680	0.0	3.7	4.0

[1]/Border rows and evaluation-selection plot to evaluate germplasm and seed lots and for possible non-bolting selection.

[2]/Powdery mildew rated 0 to 9 where 0 = no evidence of disease. Mean ratings were made on 7/12, 7/19, and 7/25/89.

TEST 488. BOLTING EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1988

160 entries x 3 replications
1-row plots, 16 ft. long Planted: November 24, 1987

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/18	P.M.[2]/ Rating
		No.	%	%	Avg.
F81-37	81101,C37	66	0.0	4.5	4.1
86-37	86443,C37	66	3.0	6.1	4.2
R774	RZM 6263,6264	67	7.5	28.4	4.2
717T	Inc. 117T(4N)	66	0.0	0.0	3.7
768	Inc. 868(US75)	71	1.4	18.3	4.7
F82-36	82421,C36	61	0.0	6.6	4.0
Y009	Inc. US 22/3	63	55.6	81.0	5.4
SP7622-0	L80466(8/87)	69	56.5	95.7	3.6
F86-31/6	86263,C31/6	66	0.0	4.5	2.8
Y731	Inc. F86-31/6	67	0.0	11.9	3.1
Y731	YR-ER-PMR Y531	64	0.0	0.0	2.8
R771	RZM 6259,6260	69	13.0	42.0	3.3
964	Inc. 364,C64	64	0.0	1.6	2.9
F85-46/2	85328,C46/2	61	0.0	0.0	1.6
86-46/2	86342,C46/2	69	0.0	1.4	1.8
F83-46	83010,C46	64	0.0	0.0	2.2
Y746	Inc. Y646	67	0.0	0.0	1.6
R773	RZM 6261,6262	65	4.6	27.7	3.4
Y639	Inc. Y539(C39)	62	3.2	16.1	1.9
Y739	YR-ER-PMR Y539	66	3.0	43.9	1.4
R739	Inc. R639-FS	67	4.5	28.4	1.6
R739(C2)	Inc. R639	64	1.6	26.6	1.6
R739(C3)	Inc. R539	68	2.9	33.8	1.4
R739(CFS)	RZM R639-FS	66	3.0	19.7	1.8
R739-4	RZM R639-4FS	66	4.5	48.5	2.3
R739-6	RZM R639-6FS	57	0.0	8.8	0.8
R739-7	RZM R639-7FS	68	5.9	51.5	1.9
Y641	Inc. Y541(C91)	65	0.0	12.3	1.0
F86-91	86019,C92	67	1.5	10.4	1.0
Y741	YR-ER-PMR Y541(C91)	65	0.0	6.2	1.2
Y749	Inc. Y649(C49)	59	6.8	33.9	2.0
Y754	Inc. Y654	63	1.6	9.5	3.4

[1]/Total number plants in 3 replications.

[2]/Powdery mildew rated 0 to 9 where 0 = no evidence of disease. Average of ratings made on 7/12, 7/18, 7/25/88.

TEST 488. BOLTING EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/18	P.M.[2]/ Rating
		No.	%	%	Avg.
Y652(Sp)	Inc. Y452Z(C92)	69	2.9	26.1	3.1
F86-92	86165,C92	63	3.2	23.8	2.6
Y752	NB Y552	70	0.0	14.3	1.9
Y552	Inc. Y452Z(C92)	60	6.7	21.7	2.9
R772	RZM 6257,6258	63	9.5	36.5	4.2
Y447	Inc. Y347	62	0.0	17.7	2.7
Y747	YR-ER-PMR Y547	64	0.0	21.9	2.1
R747	RZM R647	67	3.0	37.3	3.4
Y748	YR-ER-PMR Y548	60	0.0	11.7	3.1
Y756	YR-ER-PMR Y556(2N)	67	0.0	1.5	3.9
R703	RZM R603(Alba-C3)	68	20.6	58.8	4.3
R712	RZM R612(mixed w/7909)	65	0.0	18.5	1.8
R713	RZM R613	70	2.9	28.6	3.2
R720	RZM 6220-FS(FC)	67	25.4	46.3	3.7
R770	Inc. 6257-64-#'s	68	17.6	50.7	4.0
R702	Inc. R602	70	2.9	18.6	4.8
R718	RZM R618(Y54 x B.m.)	71	40.8	60.6	2.9
R721	RZM 6241-49(C37 x B.m.)	69	24.6	53.6	3.2
R722	Inc. F_1 & F_2(SB x B.m.)	59	47.5	78.0	3.9
5747	4747aa x A	63	0.0	11.1	3.3
6902	5902aa x A	66	0.0	6.1	1.9
7902	Inc. 5902	46	0.0	13.0	2.8
6903	YR-ER-PMR 4903	67	0.0	4.5	3.3
7903	6903aa x A	67	0.0	4.5	2.9
5904	4904aa x A	65	0.0	7.7	3.3
5905	4905-1,2,3,4aa x A	64	4.7	9.4	2.7
7905	Inc. 5905	67	1.5	9.0	3.2
7906B	6235aa x A	69	17.4	59.4	4.3
7906C	6236aa x A	73	5.5	28.8	3.8
7906D	6237aa x A	69	4.3	17.4	3.5
7907	RZM 6235	73	1.4	21.9	3.9
7908	RZM 6236	79	2.5	22.8	3.2
7909	RZM 6237	69	0.0	15.9	2.9
5743	YR-ER-PMR 3743(A,aa)	67	0.0	7.5	2.5
7743	NB 5742(A,aa)	69	1.4	4.3	2.2
4755	3755,3755Z,3757aa x A	70	5.7	27.1	3.1

TEST 488. BOLTING EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/18	P.M.[2]/ Rating
		No.	%	%	Avg.
5755	4755,4756,4802aa x A	77	2.6	24.7	3.2
7755	NB 5755(A,aa)	74	0.0	2.7	3.2
4756	3755Zaa x A	72	1.4	6.9	2.9
6756	5756Zaa x A	73	0.0	12.3	2.7
7756	NB 5756Z(A,aa)	73	1.4	8.2	2.6
6767	YR-ER-PMR 4767	66	1.5	19.7	2.0
6767	T.O. Sel 5767-#'s	63	0.0	11.1	3.1
7767	Inc. 6767aa x A	62	17.7	51.6	3.1
7767HO	6767HO x 6767	72	8.3	33.3	2.8
7768	YR-ER-PMR 5768(A,aa)	62	3.2	12.9	2.5
5776	4796H82aa x A	67	3.0	16.4	3.1
6776	YR-ER-PMR 4796H82	69	0.0	18.8	3.2
7776	6776aa x A	65	4.6	35.4	4.0
7776HO	5776HO x 6767	61	16.4	37.7	3.4
6790K	Inc. 4790K(C790)	73	1.4	4.1	2.2
7790	NB 5790(C)(A,aa)	66	0.0	4.5	2.4
7790C	5790-CO(S_1)aa x A	69	2.9	13.4	3.9
7790D	5790-SY(S_1)aa x A	70	0.0	15.7	3.9
7790F	9790Daa x A	71	2.8	21.1	3.9
7790L	4790Kaa x A	67	4.5	14.9	2.8
7790HO	6790HO x 5790	70	0.0	10.0	2.1
4796	3796Aaa x A	60	8.3	28.3	3.3
5796	4796aa x A	63	1.6	22.2	3.8
5796	YR-ER-PMR 3796(A,aa)	63	15.9	42.9	3.9
7796	NB 5796(A,aa)	69	0.0	4.3	3.0
7797	YR-ER-PMR 5797(A,aa)	72	1.4	8.3	3.9
7502	Inc. 1502(NB1)	63	0.0	6.3	3.2
5554	Inc. 7554(NB4)	64	0.0	12.5	2.1
7600(A)	Inc. 4600(C600)	64	59.4	100.0	6.6
7600(B)	Inc. 4600	61	91.8	100.0	6.7
F82-546	82372,C546	64	0.0	10.9	3.3
F78-546H3	78155,C562CMS x C546	54	1.9	22.2	3.6
F82-546H3	82460,C562CMS x C546	68	1.5	13.2	4.0
F82-562	82196,C562	62	4.8	35.5	3.9
F82-562HO	82195,C562CMS	68	1.5	22.1	4.1
5546	Inc. F82-546(C546)	62	4.8	17.7	3.4

TEST 488. BOLTING EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/18	P.M.[2]/ Rating
		No.	%	%	Avg.
5546H92	C796-22HO x F82-546	67	1.5	7.5	3.8
1512	Inc. 6512(NB6)	62	0.0	0.0	2.3
83-718	83246,C718	63	1.6	7.9	3.1
83-718HO	83245,C718CMS	60	0.0	6.7	3.5
84-306	84036,C306	71	0.0	11.3	1.7
85-306CMS	85066,C306CMS	66	0.0	6.1	2.9
F85-796-22	85062,C796-22	60	0.0	1.7	3.1
F85-796-22H3	85522,C562CMS x C796-22	63	0.0	7.9	3.8
87-309H37	87242,C306 x C309	70	1.4	5.7	4.2
87-309H37	87079,C306 x C309	70	0.0	4.3	4.1
86-309H37	86709,C306 x C309	60	1.7	11.7	4.0
87-309H3	87671,C562 x C309	71	2.8	22.5	5.0
87-309H3	87082,C562 x C309	69	1.4	13.0	4.6
86-309H3	86708,C562 x C309	70	1.4	14.3	4.2
87-309H72	87081,C718 x C309	65	0.0	0.0	4.8
87-309H92	87080,C796-22 x C306	72	0.0	5.6	5.0
F85-309	85525,C309	71	0.0	2.8	5.3
F85-309CMS	85526,C309CMS	74	1.4	14.9	5.2
86-309	86706,C309	74	2.7	9.5	4.6
86-309CMS	86707,C309CMS	70	4.3	22.9	4.9
5816	4816aa x A(C309)	66	1.5	3.0	4.1
87-309CMS	87083,C309CMS	68	0.0	11.8	4.7
87-309	87672,C309	74	2.7	10.8	3.9
87-309CMS	87670,C309CMS	69	5.8	15.9	4.3
7755-63	T-O 6755-63-#'s(A,aa)	71	1.4	8.5	3.8
7755-75	T-O 6755-75-#'s(A,aa)	70	0.0	4.3	2.8
7755-136	T-O 6755-136-#'s(A,aa)	67	0.0	4.5	0.9
7764-30	T-O 6764-30-#'s(A,aa)	70	0.0	4.3	3.0
7766-8	T-O 6766-8-#'s(A,aa)	72	13.9	20.8	3.3
7766-14	T-O 6766-14-#'s(A,aa)	60	0.0	3.3	3.7
7766-23	T-O 6766-23-#'s(A,aa)	66	3.0	1.5	4.1
7766-38	T-O 6766-38-#'s(A,aa)	67	0.0	4.5	2.0
7766-44	T-O 6766-44-#'s(A,aa)	68	0.0	1.5	1.6
7766-62	T-O 6766-62-#'s(A,aa)	69	0.0	1.4	5.0
7790-55	4790-55(C790-55)	65	0.0	0.0	3.1
7790-69	4790-69(C790-69)	47	0.0	23.4	2.6

TEST 488. BOLTING EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/18	P.M.[2]/ Rating
		No.	%	%	Avg.
7796-22	Inc. C796-22	55	0.0	0.0	3.8
6790-55	T-O 5790-55-#'s(C790-55)	65	0.0	1.5	1.7
6790-68	T-O 5790-68-#'s(C790-68)	66	1.5	12.1	1.7
6790-69	Inc. 5790-SSD-69(C790-69)	60	1.7	6.7	1.6
7816	Inc. 5816(C309)	69	1.4	2.9	4.8
7816C	5816-#'s(C309)	66	0.0	1.5	3.3
7855	RZM 6222,3	71	11.3	36.6	5.2
7824	Inc. 5824	68	0.0	0.0	2.3
B883	rec'd 3/87 from I.R.S.	51	100.0	100.0	7.1
F82-562	82196,C562	49	2.0	46.9	4.8
F82-546	82372,C546	68	0.0	5.9	3.4
F82-546H3	82460,C562 x C546	63	3.2	15.9	3.8
7850	RZM 6232(A,aa)	64	17.2	39.1	5.1
7851	RZM 6230(A,aa)	57	14.0	29.8	4.6
7852	RZM 6224(A,aa)	66	1.5	13.6	4.4
7853	RZM 6228,6229(A,aa)	74	5.4	24.3	4.9
7854	RZM 6231(A,aa)	72	2.8	11.1	4.9
7860	RZM 6233(A,aa)	67	6.0	23.9	5.2
7861	RZM 6226,6227(A,aa)	67	0.0	19.4	4.5
7862	RZM 6225(A,aa)	72	4.2	13.9	4.1

TEST 588. BOLTING EVALUATION AND OBSERVATION
TEST OF HYBRIDS, SALINAS, CA., 1988

160 entries x 3 replications
1-row plots, 16 ft. long Planted: November 24, 1987

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/17	P.M.[2]/ Rating
		No.	%	%	Avg.
US H11	685115, C546H3 x C36	73	1.3	9.6	4.1
USC-2	686495, Union	74	0.0	6.8	4.0
USC-1	83348, Union	68	0.0	5.9	3.7
SSNB3	L86061, Spreckels	71	0.0	0.0	3.5
SS-Z1	L80266, Spreckels	73	0.0	0.0	4.8
SS-Z2	11/20/85, Spreckels	70	0.0	1.4	3.8
HH37	L37368, Holly	72	0.0	4.2	3.3
HH41	L41318, Holly	76	0.0	10.5	3.7
Rizor-3	rec'd 4/87, SES	74	1.4	16.2	3.0
4625	rec'd 1/5/87, Betaseed	72	0.0	1.4	3.7
SEN 19073	rec'd 3/11/87 Fitzgerald	67	0.0	1.5	3.4
SEN 19076	" " "	70	0.0	1.4	3.6
USC-1	87075, Union	71	0.0	5.6	3.6
USC-1	87076, Union	71	0.0	1.4	3.1
USC-1	87635, Union	71	0.0	0.0	2.8
US H11	786442, C546H3 x C36	75	0.0	8.0	3.6
USC-4	787685, Union	72	2.8	4.0	3.7
USC-5	787686, Union	73	0.0	4.1	4.0
USC-6	787687, Union	65	1.5	3.1	4.1
Y731H3	F82-562HO x F86-31/6	68	0.0	14.7	3.2
Y731H8	F82-546H3 x F86-31/6	75	0.0	2.7	3.4
Y731H12	5546H26 x F86-31/6	69	0.0	5.8	3.2
Y731H13	5546H92 x F86-31/6	69	0.0	7.2	2.9
Y731H14	5546H69 x "	73	0.0	5.5	3.0
Y731H20	86-309H3 x F86-31/6	77	1.3	7.8	3.9
Y731H21	F85-309H72 x "	69	0.0	1.4	3.3
Y731H23	86-309H37 x "	69	0.0	1.4	3.7
Y731H24	5816H92 x "	70	0.0	8.6	4.2
Y731H26	86-309CMS x "	74	0.0	4.1	4.6
Y731H27	F85-796-29H3 x "	69	0.0	5.8	3.7
Y731H37	84-306CMS x "	70	0.0	2.9	2.7
Y731H42	5742-24HO x "	69	0.0	5.8	2.5

[1]/Total number plants in 3 replications.

[2]/Powdery mildew rated 0 to 9 where 0 = no evidence of disease. Average of ratings made on 7/12, 7/18, & 7/25/88.

TEST 588. BOLTING EVALUATION AND OBSERVATION
TEST OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/17	P.M.[2]/ Rating
		No.	%	%	Avg.
Y731H45	6242-45HO x F86-31/6	61	1.6	14.8	3.1
Y731H53	6834HO x "	66	0.0	18.2	3.4
Y731H66	5766-23HO x "	66	0.0	3.0	3.5
Y731H67	6767aa x F86-31/6	71	2.8	10.0	3.4
Y731H70	5766-62HO x F86-31/6	72	0.0	8.3	4.0
Y731H72	83-718HO x "	65	0.0	3.1	4.1
Y731H76	6776aa x "	73	0.0	2.7	3.6
Y731H77	5776HO x "	72	0.0	13.9	3.1
Y731H82	6756aa x "	69	0.0	8.7	3.6
Y731H87	6790-55HO x "	69	0.0	2.9	3.2
Y731H89	6790-68HO x "	70	0.0	7.1	2.8
Y731H90	6790Kaa x "	71	0.0	1.4	2.6
Y731H92	F85-796-22CMS x "	73	0.0	0.0	2.9
Y731H93	F85-796-22aa x "	72	0.0	4.2	3.6
Y731H95	5796HO x "	69	1.4	5.8	2.9
Y731H96	5796aa x "	71	2.8	16.9	3.0
Y731H99	6796-6HO x F86-31/6	72	0.0	4.2	3.6
Y731H105	6222-31aa x "	61	0.0	4.9	3.4
Y731H106	6232-33aa x "	58	0.0	6.9	3.5
Y749H8	F82-546H3 x Y649	73	1.4	13.7	2.8
Y749H26	86-309CMS x Y649	67	1.5	20.9	3.5
Y749H82	6756aa x "	68	2.9	23.5	3.1
Y754H8	F82-546H3 x Y654	62	1.6	6.5	3.1
Y754H26	86-309CMS x "	68	0.0	7.4	3.6
Y754H82	6756aa x Y654	72	1.4	9.7	2.9
R739H8	F82-546H3 x R639	74	2.7	10.8	2.4
R739H12	5546H26 x "	68	0.0	11.8	2.3
R739H13	5546H92 x "	70	0.0	11.4	2.0
R739H24	5816H92 x "	70	0.0	14.3	3.0
R739H26	86-309CMS x "	74	0.0	9.5	2.9
R739H68	6767HO x "	70	1.4	18.6	1.1
R739H77	5776HO x "	74	0.0	12.2	2.6
R739H82	6756aa x R639	70	5.7	15.7	3.4
R739H92	F85-796-22CMS x R639	64	1.6	25.0	3.2
R739H95	5796HO x "	69	0.0	24.6	3.0
R739H105	6222-31aa x "	66	0.0	16.7	3.1

TEST 588. BOLTING EVALUATION AND OBSERVATION
TEST OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/17	P.M.[2]/ Rating
		No.	%	%	Avg.
R739H106	6232-33aa x R639	68	1.5	17.6	4.0
R770H8	F82-546H3 x 6257-64	65	10.8	23.1	4.2
R770H13	5546H92 x "	69	5.8	29.0	4.0
R770H26	86-309CMS x "	70	15.7	42.9	5.0
R770H68	6767HO x "	71	8.5	29.6	4.4
R770H82	6756aa x "	66	6.1	39.4	4.1
R770H105	6222-31aa x "	66	7.6	31.8	4.0
R770H106	6232-33aa x "	70	11.4	32.9	4.5
7903H8	F82-546H3 x 6903	70	0.0	2.9	3.3
7903H24	5816H92 x "	73	0.0	0.0	3.2
7903H26	86-309CMS x "	72	0.0	5.6	3.6
7903H82	6756aa x "	72	1.4	4.2	3.3
7903H105	6222-31aa x 6903	69	0.0	1.4	3.0
7903H106	6232-33aa x "	71	0.0	9.9	3.4
7906H8	F82-546H3 x 6235,6,7	63	1.6	9.5	3.6
7906H13	5546H92 x "	66	1.5	18.2	4.4
7906H26	86-309CMS x "	72	1.4	13.9	4.1
7906H67	6767aa x "	64	4.7	17.2	3.7
7906H68	6767HO x "	63	1.6	17.5	3.5
7906H76	6776aa x "	72	4.2	12.5	4.0
7906H82	6756aa x "	72	2.8	15.3	4.4
7906H105	6222-31aa x "	71	1.4	15.5	4.2
7906H106	6232-33aa x "	60	5.0	21.7	4.0
Y746H3	F82-562HO x Y646	70	0.0	1.4	3.0
Y746H8	F82-546H3 x Y646	72	0.0	0.0	3.2
Y746H12	5546H26 x Y646	66	1.5	4.5	2.6
Y746H13	5546H92 x Y646	68	0.0	1.5	1.2
Y746H14	5546H69 x Y646	73	0.0	0.0	2.6
Y746H16	R602HO x Y646	64	0.0	7.8	2.9
Y746H17	R650HO x Y646	67	0.0	1.5	2.4
Y746H18	R660HO x Y646	68	0.0	5.9	2.7
Y746H20	86-309H3 x Y646	74	0.0	2.7	2.8
Y746H21	F85-309H72 x Y646	70	1.4	5.7	2.5
Y746H23	86-309H37 x Y646	72	0.0	1.4	2.9
Y746H24	5816H92 x Y646	73	0.0	0.0	3.1
Y746H26	86-309CMS x Y646	74	0.0	8.1	3.2

TEST 588. BOLTING EVALUATION AND OBSERVATION
TEST OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/17	P.M.[2]/ Rating
		No.	%	%	Avg.
Y746H27	F85-796-22H3 x Y646	71	0.0	0.0	2.8
Y746H32	6826HO x Y646	68	0.0	1.5	2.0
Y746H33	6827HO x Y646	65	0.0	1.5	1.9
Y746H34	6830HO x Y646	71	0.0	0.0	1.1
Y746H35	6831HO x Y646	67	0.0	3.0	2.4
Y746H36	6832HO x Y646	67	0.0	7.5	4.1
Y746H37	84-306CMS x Y646	68	0.0	1.5	1.8
Y746H41	5742-24aa x Y646	70	0.0	4.3	1.2
Y746H44	6742-45aa x Y646	57	5.3	14.0	2.6
Y746H51	6833aa x Y646	67	0.0	1.5	2.1
Y746H52	6834aa x Y646	65	0.0	1.5	1.6
Y746H55	86-309aa x Y646	77	0.0	1.3	3.2
Y746H56	5816aa x Y646	67	0.0	0.0	3.3
Y746H62	6762aa x Y646	60	0.0	1.7	1.9
Y746H64	6764-30-#aa x Y646	65	0.0	0.0	1.7
Y746H65	6766-23-#aa x Y646	65	0.0	1.5	2.3
Y746H66	5766-23HO x Y646(Iso)	65	0.0	0.0	2.0
Y746H67	6767aa x Y646	68	0.0	1.5	1.3
Y746H69	6766-62-#aa x Y646	69	0.0	0.0	3.0
Y746H70	5766-62HO x Y646	69	0.0	0.0	2.8
Y746H71	2216-46aa x Y646	72	0.0	0.0	2.3
Y746H72	83-718HO x Y646	68	0.0	1.5	1.9
Y746H73	6755-63-#aa x Y646	62	0.0	0.0	2.0
Y746H74	6755-75-#aa x Y646	64	0.0	1.6	0.4
Y746H75	6755-136-#aa x Y646	67	0.0	1.5	0.6
Y746H76	6776aa x Y646	66	0.0	3.0	1.2
Y746H78	4755Z-21aa x Y646	68	0.0	1.5	1.9
Y746H79	4755Z-23aa x Y646	67	0.0	0.0	0.9
Y746H80	4755Z-24aa x Y646	62	0.0	1.6	1.6
Y746H81	4755Z-28aa x Y646	58	0.0	6.9	2.2
Y746H82	6756aa x Y646	67	0.0	0.0	1.0
Y746H86	6790-55aa x Y646	68	0.0	1.5	2.1
Y746H88	6790-68aa x Y646	68	0.0	5.9	0.8
Y746H90	6790Kaa x Y646	69	0.0	0.0	1.9
Y746H92	F85-796-22CMS x Y646	70	0.0	0.0	1.8
Y746H107	6222-23aa x Y646	67	0.0	3.0	2.4

TEST 588. BOLTING EVALUATION AND OBSERVATION
TEST OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Stand[1]/ Count	Bolting 6/8	Bolting 8/17	P.M.[2]/ Rating
		No.	%	%	Avg.
Y746H108	6224aa x Y646	69	0.0	4.3	3.0
Y746H109	6225aa x Y646	66	0.0	4.5	2.0
Y746H110	6226-27aa x Y646	68	0.0	5.9	1.9
Y746H111	6228-29aa x Y646	65	0.0	4.6	1.9
Y746H112	6230aa x Y646	67	1.5	7.5	3.1
Y746H113	6231aa x Y646	68	0.0	1.5	2.7
Y746H114	6232aa x Y646	61	1.6	4.9	2.4
Y746H115	6233aa x Y646	71	0.0	5.6	3.1
Y639H8	F82-546H3 x Y539	74	2.7	12.2	2.2
Y639H26	F85-309CMS x Y539	71	1.4	21.1	3.2
Y641H8	F82-546H3 x Y541	68	0.0	4.4	2.7
Y641H26	F85-309CMS x Y541	75	4.0	9.3	3.1
US H11	685115, C546H3 x C36	71	1.4	2.8	4.6
Y646H8	F82-546H3 x F85-46/2	70	0.0	1.4	3.7
Y646H26	F85-309CMS x F85-46/2	75	0.0	1.3	3.2
Y652H8	F82-546H3 x Y552 (C92)	72	0.0	13.9	3.3
Y652H26	F85-309CMS x Y552 (C92)	67	0.0	6.0	3.3
6902H8	F82-546H3 x 5902	67	1.5	10.4	2.6
6903H8	F82-546H3 x 5903	69	1.4	4.3	3.7
6903H26	F85-309CMS x 5903	70	0.0	8.6	4.6

TEST 2988. ERWINIA ROOT ROT AND POWDERY MILDEW
OBSERVATION TESTS OF LINES, SALINAS, CA., 1988

176 entries x 2 reps. &
32 entries x 1 rep.
1-row plots, 20 ft. long

Planted: April 22, 1988
Inoculated: E.c.b. July 13, 1988
Harvested: October 11, 1988

Variety	Description	Roots Erwinia Reaction[1]/ No.	DI	% Resistant	P.M.[2]/ Avg.
Multigerm, Open-Pollinated					
E540	Inc. E440(C40)	42	37.8	35.7	4.7
F82-36	Inc. C36(82421)	39	0.0	100.0	4.4
964	Inc. 364(C64)	43	0.1	100.0	3.1
Y009	Inc. US 22/3	45	0.1	100.0	4.4
768	Inc. 868(US75)	52	3.7	96.0	4.5
917	Inc. 417(C17)	38	10.2	65.8	4.3
F81-37	Inc. F80-37	57	3.4	94.7	4.6
U86-37	Inc. C37(86433)	52	0.2	98.1	3.9
7903	6903aa x A	58	0.0	100.0	2.4
717T	Inc. 117T(4N)	49	27.9	55.1	2.4
F86-31/6	86263,C31/6	50	0.0	100.0	0.9
Y731	Inc. F86-31/6	36	0.1	100.0	1.4
Y731	YR-ER-PMR Y31	48	0.1	100.0	1.3
R771	RZM 6259,60	35	0.2	97.1	1.5
US H11	786442	51	0.1	98.0	5.3
E540	Inc. C40	26	38.2	46.2	5.7
85-46/2	Inc. C46/2	49	0.2	100.0	1.7
86-46/2	Inc. C46/2	46	0.0	100.0	0.9
F83-46	C46 (83010)	48	0.0	100.0	1.4
Y746	Inc. Y646	45	0.0	100.0	0.6
R773	RZM 6261,62	44	0.0	100.0	1.9
Y639	Inc. Y539(C39)	39	0.1	100.0	0.2
Y739	YR-ER-PMR Y39	47	0.0	100.0	0.7
R739	Inc. R639-FS's	38	0.1	100.0	1.7
E540	Inc. E440(C40)	42	20.6	71.4	4.7
R739(C2)	Inc. R639(Iso)	46	0.0	100.0	1.0
R739(C3)	Inc. R539(Iso)	46	0.2	97.8	0.3
R739(CFS)	RZM R639-FS's	49	2.6	96.0	0.0
F739-4	RZM R639-4	47	4.2	93.6	0.0
R739-6	RZM R639-6	32	3.2	93.8	0.0
R739-7	RZM R639-7	43	0.1	100.0	1.6
U86-37	C37(86443)	45	4.3	96.0	3.8

TEST 2988. ERWINIA ROOT ROT AND POWDERY MILDEW
OBSERVATION TESTS OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots Erwinia Reaction[1]/ No.	DI	% Resistant	P.M.[2]/ Avg.
Y641	Inc. Y541(C91)	50	0.1	98.0	1.3
F86-91	Inc. C91	41	0.1	100.0	1.2
Y741(Iso)	YR-ER-PMR Y41	48	0.4	95.8	0.8
Y749	Inc. Y649(C49)	36	0.2	97.2	1.2
Y754	Inc. Y654	44	1.1	97.7	1.7
Y454	ER-YR-PMR Y54	47	0.8	93.6	3.0
Y652(Iso)	YR-ER-PMR Y52	43	1.3	95.3	1.8
Y652Z(Iso)	YR-ER-PMRC92	50	0.3	96.0	1.7
Y652(Sp)	Inc. Y452,Z	50	0.0	100.0	0.3
F86-92	C92(86165)	42	0.0	100.0	0.5
Y752(Iso)	NB Y552	44	0.0	100.0	0.3
Y552(Sp)	Inc. C92	51	0.0	100.0	1.7
R772	RZM 6257,58	40	2.7	95.0	1.6
Y447	Inc. Y347	40	0.0	100.0	0.9
Y747(Iso)	YR-ER-PMR Y47	53	0.1	100.0	2.6
R747	RZM R647	47	0.0	100.0	2.3
US H11	786442	53	1.8	98.1	4.5
E540	Inc. E440(C40)	40	34.3	60.0	4.0
R703	RZM Alba-C3	42	10.2	88.1	3.3
R712	RZM R612	45	0.0	100.0	2.5
R713	RZM R613(FC&CA)	40	2.6	95.0	2.4
R720	RZM 6220(FC)	37	4.5	91.9	1.7
R770	Inc. 6257-64	47	0.0	100.0	2.8
R702	Inc. R602	20	6.2	80.0	4.5
R718	RZM(Y54 x *B.m.*)	45	0.0	100.0	2.3
R721(C48)	RZM 6241-49	48	0.0	100.0	3.8
R722(C50)	F_3(SB x *B.m.*)	51	5.4	90.2	3.5
F82-36	C36(82421)	38	0.2	97.4	3.4
Y748(Iso)	YR-ER-PMR Y48	46	0.1	100.0	1.7
Y756(Iso)	YR-ER-PMR Y56	47	0.1	100.0	1.1
Y656(Iso)	YR-ER-PMR Y56	49	0.3	95.9	2.9
Y754	Inc. Y654	41	0.2	97.6	1.3
Multigerm, Self-fertile, A:aa					
5747	4747aa x A	50	0.0	100.0	3.3
6902	5902aa x A	40	4.2	95.0	1.4
7903	6903aa x A	47	0.1	100.0	2.3
5904	4904aa x A	44	0.6	97.7	3.2

TEST 2988. ERWINIA ROOT ROT AND POWDERY MILDEW
OBSERVATION TESTS OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots Erwinia Reaction[1]/ No.	DI	% Resistant	P.M.[2]/ Avg.
5905	4905-#s;aa x A	42	0.0	100.0	2.9
7905(Iso)	Inc. 5905	43	0.0	100.0	3.0
7906B	6235aa x A	40	0.0	100.0	4.0
7906C	6236aa x A	40	2.1	95.0	4.1
7906D	6237aa x A	53	0.1	100.0	3.3
7907	RZM 6235	38	0.0	100.0	2.0
7908	RZM 6236	51	1.0	98.0	3.7
7909	RZM 6237	48	0.0	100.0	3.6
7903	6903aa x A	54	0.0	100.0	1.9
E540	Inc. E440(C40)	39	34.0	56.4	3.8
Y746	Inc. Y646(Iso)	51	0.1	98.0	1.5
7909	RZM 6237	46	0.0	100.0	2.5
Monogerm, Self-fertile, A:aa					
7743	NB C789/2A,aa	47	1.1	97.9	2.7
4755	3755,Z,57aa x A	54	4.8	90.7	2.3
5755	4755,6,802aa x A	45	7.8	84.4	3.1
7755	NB 5755(A,aa)	48	1.7	93.8	3.6
4756	3755Zaa x A	40	1.9	97.5	2.9
6756	5756Zaa x C310/6A	50	5.5	90.0	2.8
7756	NB 5756Z(A,aa)	50	2.8	92.0	1.6
E540	Inc. E440(C40)	31	34.8	48.4	4.6
7767	6767aa x A	51	1.5	98.0	2.3
7767HO	6767HO x 6767	51	1.6	96.1	3.1
7768(Iso)	YR-ER-PMR 768A,aa	45	2.2	95.6	2.9
5776	4796H82aa x A	48	1.7	93.8	3.7
7776	6776aa x A	51	0.0	100.0	3.4
7776HO	5776HO x 6776	37	2.5	97.3	3.8
6790K	Inc. (C790)	48	8.0	85.4	3.1
7790	NB 5790(C)(A,aa)	47	3.0	91.5	2.2
7790C	5790aa x A	44	7.2	88.6	3.7
7790L	4790Kaa x A	50	6.6	86.0	3.4
7790HO	6790HO x 5790	51	9.4	84.3	4.1
4796	3796Aaa x C796A	48	2.4	91.7	4.6
5796	4796aa x A	42	0.2	97.6	4.6
7796	NB 5796(A,aa)	32	8.7	81.3	4.7
7797	YR-ER-PMR 797A,aa	51	5.2	86.3	4.2
E540	Inc. E440(C40)	45	57.0	31.1	4.8

TEST 2988. ERWINIA ROOT ROT AND POWDERY MILDEW
OBSERVATION TESTS OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1]/ DI	Erwinia Reaction[1]/ % Resistant	P.M.[2]/ Avg.
Monogerm, Self-fertile					
F86-91	C91,86019	50	0.0	100.0	0.4
F82-546H3	82460	42	1.2	95.2	5.1
F78-546H3	78155	28	0.4	96.4	4.9
F82-546	82372	28	0.3	96.4	4.7
F82-562	82196	37	5.5	89.2	4.7
F82-562HO	82195	37	2.2	91.9	4.9
5546	Inc. F82-546	26	3.8	96.2	3.9
5546H92	C796-22HO x 546	41	0.2	97.6	4.3
83-718	83246,C718	45	0.3	95.6	3.0
83-718HO	83245,C718HO	44	4.0	93.2	4.3
84-306	84036,C306	45	4.6	84.4	0.9
85-306CMS	85066,C306CMS	34	1.9	91.2	1.7
85-796-22	C796-22	34	0.3	97.1	3.8
85-796-22CMS	C796-22CMS	48	0.5	93.8	4.6
85-796-22H3	C562HO x C796-22	44	0.6	97.7	4.2
E540	Inc. E440(C40)	45	21.7	64.4	4.5
87-309H37	87242(Wood)	59	1.3	98.3	3.5
87-309H37	87079(Clark)	50	0.0	100.0	3.5
87-309H3	87671(Wood)	54	0.9	98.1	3.7
87-309H3	87082(Clark)	44	0.1	100.0	4.0
87-309H72	87081(Clark)	48	0.0	100.0	4.5
87-309H92	87080(Clark)	47	0.0	100.0	4.4
F82-546H3	82460	45	0.1	100.0	4.0
F86-91	C91,86019	54	0.0	100.0	0.9
U86-37	C37,86443	56	0.0	100.0	3.1
5816	4816aa x C309A	44	0.0	100.0	4.7
86-309	86706(Clark)	48	1.9	93.8	4.6
86-309CMS	86707(Clark)	47	0.0	100.0	5.0
87-309	87672(Wood)	56	0.1	98.2	4.9
87-309CMS	87670(")	47	0.4	93.6	5.0
7816(Iso)	YR-ER-PMRC309	53	0.0	100.0	4.2
7816C(Iso)	YR-ER-PMRC309	57	1.1	94.7	4.8
7824(Iso)	YR-ER-PMR 824A,aa	49	1.0	98.0	0.7
7790-55	YR-ER-PMR C790-55	47	2.3	93.6	3.1
7790-69	YR-ER-PMR C790-69	16	0.0	100.0	2.4
7796-22	YR-ER-PMR C796-22	40	0.1	100.0	4.5

TEST 2988. ERWINIA ROOT ROT AND POWDERY MILDEW
OBSERVATION TESTS OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots Erwinia Reaction[1]/			P.M.[2]/
		No.	DI	% Resistant	Avg.
7850	RZM 6232A,aa	32	0.1	100.0	4.5
7851	RZM 6230A,aa	31	4.8	90.3	4.9
7852	RZM 6224A,aa	40	6.1	92.5	4.1
7853	RZM 228,9A,aa	35	2.7	97.1	3.9
7854	RZM 6231A,aa	53	5.8	88.7	4.4
7855	RZM 6222,3	47	4.3	93.6	4.4
7860	RZM 6233,A,aa	41	14.9	82.9	4.3
7861	RZM 226,7A,aa	38	16.1	81.6	4.0
7862	RZM 6225A,aa	52	3.4	94.2	4.4
7755-63	T-O 755-#A,aa	47	13.7	80.9	3.4
7755-75	T-O 755-#A,aa	42	10.5	85.7	2.5
7755-136	T-O 755-#A,aa	47	9.1	85.1	0.8
6790-55	T-O C790-55	52	11.3	82.7	1.9
6790-68	T-O C790-68	42	5.7	88.1	1.8
7766-8	T-O 6766-8	48	0.0	100.0	4.4
7766-14	T-O 6766-14	44	1.7	97.7	3.8
7766-23	T-O 6766-23	55	2.7	96.4	4.4
7766-38	T-O 6766-38	42	0.2	97.6	4.2
7766-44	T-O 6766-44	40	10.6	77.5	0.3
7766-62	T-O 6766-62	41	0.0	100.0	5.3
7764-30	T-O 6764-30	56	1.7	98.2	2.9
5742-24	Inc. 1742-24	41	2.3	97.6	3.4
6762-17	Inc. 2212-17	20	16.8	80.0	1.2
6827	T-O 5827	50	0.5	98.0	2.0
6821	Inc. 5821	29	16.5	79.3	2.6
6830	T-O 5830	42	8.9	85.7	1.0
6833	Inc. 5816H50	57	7.1	91.2	4.1
6834	Inc. 5230	40	10.6	85.0	3.7
E540	Inc. E440(C40)	50	47.7	44.0	4.2
F82-546H3	82460	39	0.0	100.0	4.6
6796-6	Inc. 5796-6	31	0.0	100.0	4.3
6796-15	Inc. 5796-15	39	0.0	100.0	4.9
6796-28	Inc. 5796-28	38	0.1	100.0	5.9
5796-43	Inc. 2796-43	39	0.7	97.4	4.1
5796-114	Inc. 2796-114	48	1.6	97.9	6.4
6790-SSD-92	5790-SSD-92	44	6.1	90.9	5.3

TEST 2988. ERWINIA ROOT ROT AND POWDERY MILDEW
OBSERVATION TESTS OF LINES, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1]/ DI	Erwinia Reaction[1]/ % Resistant	P.M.[2]/ Avg.
Half-sib families from popn-776 (1 replication)					
7776-1	6776aa x A	26	0.1	100.0	3.6
-2		22	0.3	95.5	4.6
-3		23	0.0	100.0	4.6
-4		21	0.0	100.0	3.4
-5		23	0.0	100.0	3.6
-6		19	2.7	94.7	3.2
-7		14	0.1	100.0	3.8
-8		25	0.1	100.0	4.0
-9		24	0.0	100.0	2.8
-10		24	0.0	100.0	4.8
-11		27	0.9	96.3	3.8
-12		24	0.0	100.0	3.2
-13		23	0.0	100.0	3.6
-14		20	0.0	100.0	3.8
-15		24	0.0	100.0	3.2
-16		20	0.0	100.0	4.8
7776-17		28	3.3	96.4	3.6
-18		28	3.6	92.9	3.4
-19		25	0.1	100.0	3.4
-20		28	0.0	100.0	2.8
-21		22	4.2	95.5	2.2
-22		19	0.0	100.0	3.4
-23		20	0.4	95.0	4.2
E540	Inc. E440(C40)	20	11.3	80.0	5.4
F82-546H3	82460	23	0.0	100.0	5.8
7776-24	6776aa x A	9	0.0	100.0	3.2
-25		19	1.3	94.7	3.8
-26		21	0.7	90.5	3.8
-27		27	0.3	96.3	3.8
-28		14	0.0	100.0	3.2
-29		19	0.0	100.0	3.8
-30		28	0.5	92.9	3.8

[1]/DI = disease index = approximate amount of rotted tissue. % Resistant = % of roots with 1% or less rot.

[2]/Area under disease progress curve where 0 = 0% leaf area infected to 9 = 90-100% of leaf area covered. Mean of ratings made on 8/11, 8/18, 8/26, 9/2, and 9/19/88.

Note: Even though test had very mild root rot, relative differences between lines with known reactions appear to be correct.

TEST 3088. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1988

192 entries x 2 replications
1-row plots, 20 ft. long

Planted: April 22, 1988
Inoculated: E.c.b. July 14, 1988
Harvested: October 19, 1988

Variety	Description	Roots Erwinia Reaction[1]/ No.	DI	% Resistant	P.M.[2]/ Avg.
US H11	786442,546H3 x C36	44	3.2	90.9	4.8
E540	Inc. E440(C40)	28	73.7	21.4	4.6
HH37	37348	42	17.0	66.7	4.0
Rhizosen	1/5/88	37	4.8	89.2	3.4
SS-Z1	Spreckels 1/22/88	24	5.6	87.5	4.4
SS-Z2	"	44	7.9	77.3	5.1
SS-NB2	"	48	1.0	91.7	4.6
SS-NB3	"	29	9.0	86.2	4.6
H83223	"	45	2.4	93.3	3.6
4625	Betaseed(7336-2)	43	2.5	93.0	3.8
B6625	" (70331-2)	42	13.0	83.3	2.9
USC-1	787075,Union	47	0.1	97.9	4.0
USC-4	Union(787685)	53	1.9	96.2	4.0
USC-5	" (787686)	51	2.6	92.2	4.6
USC-6	" (787687)	51	8.0	84.3	4.8
HH41	Holly(41318)	39	15.3	61.5	4.6
717T	Inc. 117T(C17T)	43	47.0	7.0	4.5
717TH26	309CMS x 117T	58	24.5	46.6	5.0
Rizor-3	4/87	33	1.9	90.9	4.9
Y731H3	562HO x 31/6	36	9.9	69.4	3.7
Y731H8	546H3 x 31/6	33	4.5	84.8	3.0
Y731H12	5546H26 x 31/6	47	1.0	91.5	3.7
Y731H13	5546H92 x 31/6	44	3.9	86.4	3.6
Y731H14	5546H69 x "	32	0.9	87.5	3.7
Y731H20	86-309H3 x 31/6	46	10.7	76.1	3.5
Y731H21	309H72 x "	45	5.7	86.7	3.6
Y731H23	86-309H37 x "	47	2.3	93.6	4.1
Y731H24	5816H92 x "	46	3.6	84.8	4.2
Y731H26	86-309CMS x "	43	3.1	90.7	4.3
Y731H27	796-22H3 x "	48	0.2	97.9	3.6
Y731H37	84-306CMS x "	37	8.2	83.8	3.2
Y731H42	5742-24HO x "	35	2.2	94.3	3.1

TEST 3088. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1]/ DI	Erwinia Reaction[1]/ % Resistant	P.M.[2]/ Avg.
US H11	786442	41	0.6	97.6	5.4
Y731H53	6834HO x 31/6	39	5.4	87.2	3.2
Y731H66	5766-23HO x 31/6	54	6.0	92.6	3.2
Y731H67	6767aa x F86-31/6	44	0.5	93.2	2.8
Y731H70	5766-62HO x 31/6	47	3.2	95.7	3.9
Y731H72	83-718HO x "	43	8.6	81.4	2.7
Y731H76	6776(Iso)aa x "	40	4.4	87.5	3.1
Y731H77	5776HO x "	45	4.2	91.1	3.1
Y731H82	6756aa x "	49	10.4	79.6	2.6
Y731H87	6790-55HO x "	40	6.7	70.0	3.2
Y731H89	6790-68HO x "	42	6.8	83.3	3.2
Y731H90	6790Kaa x "	41	15.6	68.3	2.8
Y731H92	796-22CMS x "	36	10.4	83.3	3.4
Y731H93	796-22aa x "	47	3.2	91.5	3.8
Y731H95	5796HO x "	42	5.6	88.1	3.7
Y731H96	5796(Iso)aa x "	48	5.6	91.7	3.0
Y731H99	6796-6HO x 31/6	40	2.1	95.0	3.9
Y731H105	6222,6231aa x "	38	7.2	81.6	3.4
Y731H106	6232,33aa x "	46	8.5	76.1	3.5
Y749H8	546H3 x Y649	41	7.3	85.4	2.8
Y749H26	86-309CMS x Y649	52	6.5	80.8	3.5
Y749H82	6756aa x "	48	3.3	85.4	2.2
Y754H8	546H3 x Y654	42	2.0	92.9	3.8
Y754H26	309CMS x "	53	3.2	88.7	4.9
Y754H82	6756aa x Y654	41	3.0	87.8	2.3
R739H8	546H3 x R639	42	5.6	88.1	3.1
R739H12	5546H26 x "	46	0.8	93.5	3.3
R739H13	5546H92 x "	48	2.5	95.8	3.3
R739H24	5816H92 x "	47	3.4	91.5	3.9
R739H26	309CMS x "	53	3.5	92.5	4.0
R739H68	6767HO x "	50	7.3	84.0	2.9
R739H77	5776HO x "	49	4.6	87.8	3.5
R739H82	6756aa x R639	50	6.8	82.0	2.3
R739H92	796-22CMS x R639	47	6.4	74.5	2.5
R739H95	5796HO x "	43	5.3	79.1	2.4
R739H105	6222,31aa x "	40	13.6	75.0	2.8

TEST 3088. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1]/ DI	% Resistant	P.M.[2]/ Avg.
R739H106	6232,33aa x "	42	9.8	78.6	4.0
R770H8	546H3 x 6257-64	40	2.3	90.0	4.4
R770H13	5546H92 x "	41	0.5	92.7	4.5
R770H26	309CMS x "	47	6.0	76.6	5.1
R770H68	6767HO x 6257-64	35	0.1	100.0	3.4
R770H82	6756aa x "	47	0.1	100.0	4.1
R770H105	6222,31aa x "	37	5.3	91.9	3.6
R770H106	6232,33aa x "	45	0.1	100.0	4.1
7903H8	546H3 x 6903	35	0.3	97.1	4.3
7903H24	5816H92 x "	53	0.5	98.1	4.0
7903H26	86-309CMS x "	55	0.3	96.4	4.7
7903H82	6756aa x "	45	3.9	93.3	3.8
7903H105	6222,31aa x 6903	41	0.0	100.0	4.1
7903H106	6232,33aa x "	40	2.5	92.5	4.0
7906H8	546H3 x 6235,6,7	38	0.2	97.4	4.6
7906H13	5546H92 x "	46	0.0	100.0	4.4
7906H26	309CMS x "	49	2.0	95.9	5.3
7906H67	6767aa x "	42	1.3	95.2	4.5
7906H68	6767HO x "	38	4.6	89.5	4.2
7906H76	6776aa x "	42	2.0	92.9	4.1
7906H82	6756aa x "	46	6.5	87.0	3.4
7906H105	6222,31aa x "	38	2.9	89.5	4.4
7906H106	6232,33aa x "	38	4.5	94.7	4.4
Y746H3	562HO x Y646	43	3.3	93.0	3.5
Y746H8	546H3 x Y646	44	3.9	88.6	3.1
Y746H12	5546H26 x Y646	46	7.6	87.0	3.6
Y746H13	5546H92 x Y646	45	5.9	86.7	2.5
Y746H14	5546H69 x Y646	43	12.2	76.7	2.4
Y746H16	R602HO x Y646	41	4.8	92.7	2.3
Y746H17	R650HO x Y646	37	11.5	73.0	2.2
Y746H18	R660HO x Y646	44	6.2	81.8	2.8
Y746H20	309H3 x Y646	50	10.8	84.0	4.0
Y746H21	309H72 x Y646	55	8.0	80.0	4.1
Y746H23	309H37 x Y646	50	7.1	76.0	3.5
Y746H24	5816H92 x Y646	51	6.7	84.3	4.2
Y746H26	309CMS x Y646	54	6.5	88.9	4.8

TEST 3088. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots Erwinia Reaction[1]/ No.	DI	% Resistant	P.M.[2]/ Avg.
Y746H27	796-22H3 x Y646	42	1.4	95.2	3.6
US H11	786442	42	0.6	97.6	4.6
Y746H33	6827HO x Y646	49	4.5	93.9	3.1
Y746H34	6830HO x Y646	44	4.8	86.4	1.6
E540	Inc. E440(C40)	32	58.3	31.3	5.0
F86-91	Inc. C91	46	0.6	97.8	2.0
Y746H37	306CMS x Y646	48	4.9	89.6	2.6
Y746H41	5742-24aa x Y646	49	2.6	93.9	2.0
Y746H44	6742-45aa x Y646	48	0.7	95.8	2.1
Y746H51	6833aa x Y646	53	3.8	94.3	3.6
Y746H52	6834aa x Y646	48	3.1	95.8	3.5
Y746H55	309aa x Y646	48	2.4	91.7	3.7
Y746H56	5816aa x Y646	58	5.2	89.7	4.2
Y746H62	6762aa x Y646	43	7.2	83.7	2.6
Y746H64	6764-#aa x Y646	47	1.1	95.7	1.7
Y746H65	6766-#aa x Y646	53	4.5	88.7	3.4
Y746H66	5766-23HO x Y646	51	4.3	92.2	2.9
Y746H67	6767aa x Y646	53	1.2	92.5	2.2
Y746H69	6766-#aa x Y646	49	1.9	98.0	3.6
Y746H70	5766-62HO x Y646	48	2.3	91.7	4.3
Y746H71	2216-46aa x Y646	53	4.0	94.3	3.5
Y746H72	718HO x Y646	51	4.5	88.2	3.2
Y746H73	755-63-#aa x Y646	46	6.8	91.3	3.7
Y746H74	755-75-#aa x Y646	45	5.8	93.3	2.0
Y746H75	755-136-#aa x Y646	48	7.9	85.4	1.6
Y746H76	776aa x Y646	50	5.2	94.0	3.7
US H11	786442	51	2.5	94.1	5.4
E540	Inc. E440(C40)	34	63.0	26.5	5.8
F86-91	Inc. C91	53	0.1	100.0	2.1
U86-46/2	Inc. C46/2	39	0.2	97.4	2.0
Y746H82	6756aa x Y646	52	6.4	84.6	2.5
Y746H86	6790-55aa x Y646	53	8.8	81.1	1.8
Y746H88	6790-68aa x Y646	36	5.3	86.1	2.5
Y746H90	6790Kaa x Y646	48	6.4	85.4	3.1
Y746H92	796-22CMS x Y646	48	1.5	91.7	3.6
Y746H107	6222,23aa x Y646	57	17.0	70.2	4.4

TEST 3088. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots Erwinia Reaction[1]/			P.M.[2]/
		No.	DI	% Resistant	Avg.
Y746H108	6224aa x Y646	52	18.0	75.0	2.8
Y746H109	6225aa x Y646	46	8.9	80.4	3.0
Y746H110	6226,27aa x Y646	45	5.0	86.7	3.6
Y746H111	6228,29aa x Y646	51	7.4	84.3	3.2
Y746H112	6230aa x Y646	43	5.3	93.0	3.2
Y746H113	6231aa x Y646	45	1.8	95.6	3.0
Y746H114	6232aa x Y646	42	4.5	85.7	2.7
Y746H115	6233aa x Y646	48	5.8	91.7	2.7
Y639H8	546H3 x Y539	45	5.9	93.3	2.6
Y639H26	309CMS x Y539	50	3.0	94.0	3.5
Y641H8	546H3 x Y541	52	0.2	98.1	2.3
Y641H26	309CMS x R541	51	0.2	98.0	4.5
US H11	685115	47	1.0	91.5	4.4
Y646H8	546H3 x 46/2	45	0	100.0	4.0
Y646H26	309CMS x 46/2	54	2.1	94.4	4.7
Y652H8	546H3 x C92	48	0.0	100.0	3.3
Y652H26	309CMS x C92	60	1.8	93.3	3.9
E540	Inc. E440(C40)	36	45.6	36.1	5.2
6903H8	546H3 x 5903	40	0.0	100.0	5.0
6903H26	309CMS x 5903	53	3.0	92.5	5.7
Top-crosses of 6235-S_1aa x popn-767					
7767H101-1	6235-1aa x 6767	43	2.1	93.0	3.8
-3	" -5aa x "	35	1.0	85.7	3.5
-5	" -10aa x "	42	0.2	97.6	4.2
-6	" -12aa x "	38	6.1	84.2	3.8
-7	" -14aa x "	38	3.1	89.5	3.9
-9	" -16aa x "	46	2.2	95.7	4.7
-10	" -17aa x "	41	0.2	97.6	4.0
-11	" -21aa x "	46	0.6	97.8	5.3
-12	" -23aa x "	38	2.2	94.7	4.2
-14	" -28aa x "	43	8.4	88.4	3.6
-16	" -34aa x "	48	12.9	83.3	4.7
Top-crosses of 6236-FSaa x popn-767					
7767H102-17	6236-1aa x 6767	50	2.9	96.0	4.0
-18	" -2aa x "	53	1.8	92.5	4.0

TEST 3088. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1988
(Continued)

Variety	Description	Roots Erwinia Reaction[1]/ No.	DI	% Resistant	P.M.[2]/ Avg.
-19	" -3aa x "	44	1.1	95.5	4.0
-20	" -4aa x "	41	0.0	100.0	4.5
-21	" -5aa x "	50	4.5	90.0	4.7
-22	" -6aa x "	52	0.0	100.0	4.7
-23	" -7aa x "	42	0.0	100.0	4.5
-24	" -8aa x "	47	0.1	100.0	4.4
-25	" -9aa x "	51	2.5	96.1	3.8
-26	" -10aa x "	54	4.2	94.4	3.6
-27	" -11aa x "	53	0.2	98.1	3.8
Top-crosses of 6237-FSaa x popn-767					
7767H103-28	6237-12aa x 6767	37	2.5	97.3	3.1
-29	" -13aa x "	54	0.1	100.0	4.0
-30	" -14aa x "	48	2.0	97.9	3.4
-31	" -15aa x "	49	2.6	93.9	4.4
-32	" -16aa x "	53	2.2	94.3	4.9
-33	" -17aa x "	42	4.4	90.5	4.6
-34	" -18aa x "	48	2.2	87.5	3.8
US H11	786442	41	2.3	97.6	6.2
E540	Inc. E540(C40)	33	57.2	30.3	5.7
7906H68	6767HO x 6235,6,7	43	1.1	90.7	5.1

Note: Severity of both Erwinia root rot and powdery mildew was moderate.

[1]/DI = disease index = approximate amount of rotted tissue.
% Resistant = % of roots with 1% rot or less.
[2]/Area under disease progress curve where 0 = 0% leaf area infected to 9 = 90-100% of leaf area covered. Mean of ratings made on 8/11, 8/18, 8/26, 9/2, and 9/19/88.

TESTS 188 & 3188. ERWINIA ROOT ROT, POWDERY MILDEW, AND BOLTING EVALUATION OF HALF-SIB FAMILIES FROM C31/6, SALINAS, CA., 1988

Planted: April 22, 1988
Inoculated: E.c.b. July 14, 1988
Harvested: October 17, 1988

120[6]/ entries x 1 replications
1-row plots, 20 ft. long

Planted: November 19, 1987

100 entries x 3 replications
1-row plots, 16 ft. long

	Test 3188				Test 188			
		Erwinia Reaction[1]/		P.M.[2]/	Stand	Bolting		P.M.[4]/
Variety[3]/	Roots No.	DI	% Resistant	Rating Avg.	Count No.[5]/	6/9 %	9/7 %	Rating Avg.
Y731-1	15	0.0	100.0	1.8	22	0.0	4.5	2.0
-2	14	0.0	100.0	1.4	21	3.1	18.8	2.0
-3	15	0.0	100.0	3.0	23	1.4	8.6	2.1
-4	10	0.0	100.0	0.4	21	1.6	3.2	0.4
-5	16	1.4	75.0	1.0	23	0.0	4.3	1.3
-6	22	4.3	95.5	2.0	22	0.0	16.7	2.6
-7	20	4.8	95.0	1.6	20	0.0	4.9	2.6
-8	18	0.1	100.0	1.8	21	0.0	4.7	1.4
-9	22	0.1	100.0	4.4	23	0.0	13.2	2.8
-10	19	0.1	100.0	1.8	21	1.6	11.3	1.6
-11	20	3.9	90.0	2.8	24	0.0	11.3	1.4
-12	21	9.3	85.7	4.2	22	0.0	12.1	1.9
-13	18	0.0	100.0	2.2	21	7.8	21.9	2.0
-14	20	0.0	100.0	3.4	22	1.5	9.0	2.1
-15	15	0.0	100.0	2.4	20	0.0	0.0	1.2
-16	22	0.5	95.5	2.2	23	0.0	10.1	1.5
-17	18	0.1	100.0	2.2	24	0.0	7.0	2.2
-18	20	14.2	70.0	1.4	23	0.0	4.4	1.3
-19	18	5.3	94.4	1.6	20	0.0	8.4	1.3
-20	16	7.6	75.0	2.8	21	1.6	10.9	1.8

TESTS 188 & 3188. ERWINIA ROOT ROT, POWDERY MILDEW, AND BOLTING EVALUATION OF HALF-SIB FAMILIES FROM C31/6, SALINAS, CA., 1988
(Continued)

Variety[3]	Test 3188				Test 188			
	Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Rating Avg.	Stand Count No.[5]	Bolting 6/9 %	Bolting 9/7 %	P.M.[4] Rating Avg.
Y731-21	20	0.5	95.0	3.4	22	1.5	19.7	1.8
-22	21	2.9	86.4	3.0	20	3.3	26.7	2.1
-23	14	5.4	92.9	1.8	22	0.0	10.8	1.5
-24	18	0.1	100.0	2.0	20	1.6	11.5	1.8
-25	23	0.1	100.0	4.4	20	1.7	11.9	3.2
-26	13	0.1	100.0	3.2	22	0.0	1.5	1.9
-27	17	5.5	94.1	1.2	23	0.0	21.4	1.9
-28	17	0.5	94.1	2.0	24	0.0	4.2	2.1
-29	19	5.3	94.7	3.2	23	1.4	7.1	1.7
-30	17	5.6	94.1	1.8	23	2.9	10.1	1.3
-31	17	0.1	100.0	1.2	21	1.6	7.8	2.2
-32	15	0.1	100.0	2.0	24	0.0	2.8	2.2
-33	21	10.9	85.7	3.4	22	0.0	4.6	2.8
-34	21	0.1	100.0	2.6	20	3.3	13.1	2.2
-35	24	0.0	100.0	2.2	18	5.7	30.2	1.6
-36	22	0.3	95.5	2.4	22	0.0	6.1	2.1
-37	21	0.0	100.0	2.8	24	0.0	12.3	1.7
-38	19	1.2	84.2	1.8	20	0.0	7.8	2.0
-39	21	0.1	100.0	1.2	24	0.0	10.8	0.8
-40	20	4.2	90.0	1.6	19	1.7	18.6	1.0
-41	21	3.6	95.2	0.8	22	1.5	13.8	1.6
-42	26	0.1	100.0	2.6	22	1.5	3.0	2.5
-43	24	0.0	100.0	3.4	25	0.0	8.2	2.5
-44	23	8.0	82.6	4.4	24	0.0	2.3	2.1
-45	23	16.8	78.3	2.6	24	0.0	17.1	1.9

TESTS 188 & 3188. ERWINIA ROOT ROT, POWDERY MILDEW, AND BOLTING EVALUATION OF HALF-SIB FAMILIES FROM C31/6, SALINAS, CA., 1988
(Continued)

Variety[3]	Test 3188 Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	Test 3188 P.M.[2] Rating Avg.	Test 188 Stand Count No.[5]	Test 188 Bolting 6/9 %	Test 188 Bolting 9/7 %	Test 188 P.M.[4] Rating Avg.
Y731-46	25	0.1	100.0	1.8	22	0.0	2.3	2.2
-47	17	4.5	88.2	2.2	25	0.0	4.5	2.0
-48	18	1.4	94.4	1.8	22	0.0	4.8	2.5
-49	21	0.0	100.0	3.4	23	0.0	1.5	1.3
-50	27	0.0	100.0	3.2	22	0.0	26.2	1.6
-51	27	3.5	92.6	2.0	24	0.0	10.3	2.3
-52	18	1.5	94.4	2.8	23	0.0	11.3	2.5
-53	22	0.1	100.0	2.4	21	0.0	4.5	3.0
-54	18	0.1	100.0	2.0	22	0.0	4.5	1.1
-55	15	10.1	86.7	0.6	23	1.0	12.3	1.3
-56	20	4.6	85.0	3.4	23	0.0	11.6	2.1
-57	14	5.4	92.9	0.4	21	1.8	3.6	2.0
-58	19	5.3	89.5	2.2	23	1.6	4.8	1.7
-59	22	1.0	86.4	0.8	22	0.0	4.6	1.4
-60	15	0.1	100.0	2.2	23	0.0	10.6	2.3
-61	20	13.0	75.0	1.6	22	1.6	3.2	1.6
-62	22	5.0	86.4	1.8	20	1.7	16.7	2.1
-63	21	8.0	90.5	2.6	21	1.5	4.4	2.0
-64	21	0.0	100.0	1.4	26	0.0	2.8	2.4
-65	15	0.1	100.0	1.4	19	1.7	15.5	1.3
-66	16	0.0	100.0	1.6	21	0.0	15.4	1.7
-67	19	5.6	84.2	0.4	24	0.0	7.5	1.8
-68	14	5.4	92.9	0.8	23	0.0	7.2	1.9
-69	22	5.7	90.9	0.8	22	0.0	1.5	2.1
-70	16	0.1	100.0	3.0	20	0.0	1.6	1.4

TESTS 188 & 3188. ERWINIA ROOT ROT, POWDERY MILDEW, AND BOLTING EVALUATION OF HALF-SIB FAMILIES FROM C31/6, SALINAS, CA., 1988
(Continued)

Variety[3]	Test 3188				Test 188			
	Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Rating Avg.	Stand Count No.[5]	Bolting 6/9 %	Bolting 9/7 %	P.M.[4] Rating Avg.
Y731-71	21	0.5	95.2	1.8	23	0.0	25.8	1.8
-72	19	0.1	100.0	1.0	19	0.0	6.3	2.3
-73	13	1.2	84.6	2.0	16	0.0	6.9	2.1
-74	24	1.3	95.8	1.4	21	1.0	19.4	1.8
-75	16	5.9	93.8	0.4	25	0.0	10.0	0.9
76	16	0.0	100.0	2.8	21	0.0	6.3	2.3
-77	18	27.0	61.1	1.6	22	0.0	6.0	1.6
-78	22	3.5	95.5	0.2	19	0.0	8.8	1.1
-79	16	0.1	100.0	1.8	23	0.0	14.5	2.4
-80	19	0.0	100.0	2.6	22	0.0	12.1	1.4
-81	17	0.4	94.1	2.8	22	0.0	9.0	3.6
-82	19	0.1	100.0	2.0	23	1.5	23.5	2.7
-83	21	3.9	90.5	1.4	23	0.0	5.8	1.7
-84	19	0.1	100.0	2.6	22	1.5	19.7	1.8
-85	10	7.5	90.0	2.0	12	0.0	2.9	1.8
-86	18	0.1	100.0	1.4	22	0.0	18.2	1.9
-87	21	4.5	95.2	2.2	24	0.0	4.2	2.3
-88	18	5.7	94.4	2.8	21	0.0	15.6	2.6
-89	21	0.1	100.0	1.0	22	1.5	9.2	1.8
-90	22	0.6	90.9	1.8	21	1.6	27.0	2.2
-91	19	0.5	94.7	2.6	21	0.0	9.7	2.3
-92	23	0.1	100.0	2.2	23	0.0	1.5	1.5
-93	23	0.0	100.0	1.4	22	0.0	9.1	2.0
-94	24	0.0	100.0	3.0	23	0.0	8.7	0.7
-95	14	0.0	100.0	3.2	13	0.0	7.7	2.1

TESTS 188 & 3188. ERWINIA ROOT ROT, POWDERY MILDEW, AND BOLTING EVALUATION OF HALF-SIB FAMILIES FROM C31/6, SALINAS, CA., 1988
(Continued)

Variety[3]	Test 3188 Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	Test 3188 P.M.[2] Rating Avg.	Test 188 Stand Count No.[5]	Test 188 Bolting 6/9 %	Test 188 Bolting 9/7 %	Test 188 P.M.[4] Rating Avg.
Y731-96	18	0.0	100.0	1.0	21	0.0	6.3	0.4
-97	23	0.0	100.0	1.4	23	0.0	10.0	2.6
-98	22	0.0	100.0	3.6	19	0.0	17.9	2.6
-99	16	6.4	87.5	1.4	21	1.6	6.3	1.9
-100	25	0.0	100.0	1.4	23	1.5	10.3	1.4
Checks[6]								
E540(C40)	215	54.1	33.3	5.7				
US H11	237	1.3	96.4	5.1				

[1] DI = disease index = approximate amount of rotted tissue. % Resistant = % of roots with 1% or less rot.

[2] Area under disease progress curve where 0 = 0% leaf area infected to 9 = 90-100% of leaf area covered. Mean of ratings made on 8/11, 8/18, 8/26, 9/2, and 9/19/88.

[3] Y731-#'s = Half-sib families from F86-31/6 produced for evaluation of BYV resistance and yield at Davis, CA. by Dr. S. Temple and at Salinas (Test 1688).

[4] Powdery mildew rated 0 to 9 where 0 = no evidence of disease. Mean of ratings made on 7/12, 7/19, and 7/25/1988.

[5] Average of 3 replications.

[6] C40 and US H11 checks were included 10 times each.

TEST 2888. POWDERY MILDEW EVALUATION OF TEST AND MARKET HYBRIDS, 1988 (SPENCE 2888)

Planted: April 21, 1988
80 entries x 6 replications
1-row plots, 16 ft. long

Entry No.	Variety	Co.	No. Plants[1]/	Powdery Mildew Rating[2]/ 8/11	8/18	8/26	9/2	9/19	Mean
88-PM-1	MH3002	H[3]/	129	1.5	2.2	2.2	2.7	4.0	2.5
-2	4BX8823	B	130	1.0	1.8	1.8	2.2	3.8	2.1
-3	86-1459-029	HS	133	3.7	4.7	5.0	5.0	6.0	4.9
-4	4625	B	141	2.0	2.7	2.7	3.0	3.8	2.8
-5	86-84C25-020	HS	134	3.0	4.0	4.2	3.8	4.7	3.9
-6	3X8813	B	137	2.0	2.8	2.8	3.0	4.2	3.0
-7	86-84C80-019	HS	126	2.0	3.7	4.0	4.0	4.7	3.7
-8	4BG5549	B	132	1.8	2.3	2.5	3.7	4.5	3.0
-9	86C148-021	HS	133	3.0	3.5	3.5	4.0	4.8	3.8
-10	USC-6	U	139	4.2	4.8	5.3	5.2	5.7	5.0
-11	86-84C25-013	HS	120	2.7	3.2	3.5	4.2	4.7	3.6
-12	SS-NB3	SS	122	3.5	3.8	4.0	4.7	4.8	4.2
-13	86-84C36-012	HS	134	3.2	4.2	4.7	4.3	5.0	4.3
-14	MH5330	H	108	2.3	2.7	2.5	2.2	3.3	2.6
-15	HH38	HS	121	1.8	3.0	3.0	3.5	3.8	3.0
-16	4BG5600	B	114	3.0	4.0	4.2	4.3	5.5	4.2
-17	MH6036	H	125	2.5	3.3	3.8	3.7	5.0	3.7
-18	H83175	SS	126	2.8	3.5	3.3	4.5	5.0	3.8
-19	H86535	SS	151	3.7	4.5	4.7	5.0	6.0	4.8
-20	H85207	SS	105	3.0	3.8	3.8	4.0	5.0	3.9
-21	6BG6151	B	133	4.0	4.8	5.2	4.8	6.3	5.0
-22	SS-Y1	SS	133	2.5	3.5	3.8	3.7	4.8	3.7
-23	H83165	SS	137	2.5	3.7	4.2	4.3	4.7	3.9
-24	H85364	SS	140	3.2	4.0	3.8	4.2	4.2	3.9
-25	H86502	SS	142	3.2	3.8	4.0	3.8	5.0	4.0
-26	84C39-027	HS	130	2.5	3.5	3.8	3.8	4.5	3.6
-27	84C39-022	HS	123	2.7	3.8	4.0	4.0	4.0	3.7
-74	MH148	H	136	4.3	5.0	5.2	4.5	5.5	4.9
-29	6BC6280	B	131	1.2	1.7	1.8	2.2	3.8	2.1
-30	85N148-08	HS	127	2.7	3.5	3.8	3.0	4.7	3.5
-31	USC-1	U	126	2.7	3.5	4.0	3.5	4.8	3.7
-32	H85231	SS	137	2.3	3.7	3.7	4.2	4.3	3.6
-33	SS-Z2	SS	126	3.3	4.5	4.8	4.5	5.5	4.5
-34	6BG6085	B	130	0.5	2.0	2.0	3.2	3.8	2.3
-35	SS-LS2	SS	132	3.7	4.2	4.3	4.5	5.3	4.4
-36	86C15-016	HS	121	4.0	4.7	4.8	4.3	5.3	4.6

TEST 2888. POWDERY MILDEW EVALUATION OF TEST AND MARKET HYBRIDS, 1988 (SPENCE 2888) (Continued)

Entry No.	Variety	Co.	No. Plants[1]/	Powdery Mildew Rating[2]/ 8/11	8/18	8/26	9/2	9/19	Mean
88-PM-37	84C39-015	HS	122	3.2	3.7	3.8	3.7	4.8	3.8
-38	Hill 1	H	115	0.8	1.7	1.7	3.2	4.2	2.3
-39	4587	B	129	3.0	3.5	3.8	3.7	4.7	3.7
-40	HH41	HS	129	3.0	3.2	3.7	3.7	3.8	3.5
-41	84C39-018	HS	127	1.8	2.3	2.8	2.7	4.3	2.8
-75	6BG6155	B	130	3.7	4.3	4.5	4.7	5.3	4.5
-43	SS-NB2	SS	137	3.0	3.5	3.7	4.5	5.2	4.0
-44	4757	B	136	1.2	1.5	1.7	2.3	3.5	2.0
-45	HH37	HS	129	2.8	3.5	3.8	4.3	4.8	3.9
-46	MH3001	H	139	2.2	3.5	3.7	3.5	3.8	3.3
-47	USC-4	U	130	2.6	3.7	3.7	3.5	4.2	3.5
-48	H84334	SS	145	3.3	4.2	4.3	4.3	5.3	4.3
-49	4654	B	138	2.0	3.0	3.2	3.7	4.2	3.2
-50	86C13-010	HS	133	3.2	3.7	3.8	3.8	4.8	3.9
-51	84C39-033	HS	143	2.3	3.7	4.0	3.7	4.5	3.6
-52	H83302	SS	143	3.3	3.5	3.7	3.8	4.8	3.8
-53	84C39-024	HS	129	2.2	3.2	3.5	4.0	4.5	3.5
-54	85C24-08	HS	114	3.5	4.5	4.5	4.5	5.3	4.5
-55	HH45	HS	144	2.2	3.0	3.0	2.8	3.8	3.0
-56	MH3004	H	131	3.3	4.7	4.3	3.8	4.8	4.2
-57	86C148-018	HS	136	2.6	3.2	3.5	3.7	4.0	3.4
-58	84-29-10	FM	133	2.8	3.7	3.8	3.3	4.3	3.6
-59	MH6027	H	148	2.0	3.7	3.8	3.5	4.3	3.5
-60	HH46	HS	137	2.3	4.0	4.0	3.8	4.5	3.7
-61	85C35-03	HS	126	1.2	2.7	2.8	3.2	3.3	2.6
-62	H84270	SS	130	2.2	3.3	3.7	4.2	4.7	3.6
-63	85C44-07	HS	120	2.3	3.0	3.2	3.0	4.2	3.1
-64	H84377	SS	127	2.5	3.0	3.0	3.5	4.5	3.0
-65	84C39-029	HS	130	2.3	3.0	3.2	3.7	4.5	3.3
-66	Rhizosen	HS	126	2.2	3.5	3.5	4.0	4.7	3.6
-67	4BX8803	B	119	0.5	1.0	1.0	1.7	3.0	1.4
-68	Hill 2	H	129	0.3	1.3	1.7	2.8	3.7	2.0
-69	H86548	SS	130	4.3	5.5	6.0	5.3	6.8	5.6
-70	84C39-036	HS	139	3.0	3.8	4.2	4.0	4.7	3.9
-71	SS-Z1	SS	120	3.5	4.0	4.3	4.2	5.2	4.2
-72	H84181	SS	121	3.3	3.8	3.8	4.0	4.5	3.9

TEST 2888. POWDERY MILDEW EVALUATION OF TEST AND MARKET HYBRIDS, 1988 (SPENCE 2888) (Continued)

Entry No.	Variety	Co.	No. Plants[1]/	Powdery Mildew Rating[2]/ 8/11	8/18	8/26	9/2	9/19	Mean
88-PM-73	USC-5	U	129	3.0	3.8	4.0	4.0	4.8	3.9
US H11	CBGA Check		131	4.2	4.8	5.0	5.3	5.5	5.0
US H11	USDA Susc. Check		132	4.0	4.8	5.2	5.2	5.8	5.0
US H11	" " "		134	4.0	4.5	5.0	5.0	5.8	4.9
US H11	" " "		131	3.7	4.7	4.8	4.7	5.7	4.7
US H11	" " "		130	4.0	4.7	4.8	4.8	6.0	4.9
F86-91	USDA Resist. Check		117	0.5	0.8	0.8	1.7	2.7	1.3
F86-91	" " "		128	0.0	0.3	0.3	0.2	2.8	0.7

[1]/ Total number of plants over six replications.

[2]/ Powdery mildew scored on 8/11, 8/18, 8/26, 9/2, and 9/19/88 Where 0 = 0% leaf area infected to 9 = 90-100% covered. Mean approximately equals area under disease progress curve. Disease severity was only moderate but relative ratings appeared to be reliable. The five entries of US H11 gave consistent results.

[3]/ Company designation: H = Hilleshog, B = Betaseed, FM = Ferry-Morse, HS = Holly, SS = Spreckels, and U = Union.

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1988

150 entries x 3 replications
1-row plots, 15 ft. long
Test Conducted by Terry Brown, BSDF

Planted: June 14, 1988
Inoculated: July 14, 1988

Variety	Description MS	T-O	Male	CT Grade 8/23	9/12
CHECKS					
RB	Red Beet			7.7	8.8
546H3	Check(NC)			3.7	3.7
US 33	Check(I)			4.5	5.0*
US 41	Check(R)			3.7	3.8*
HYBRIDS					
US H11	C562	C546	C36	3.1	3.7
HH 37	Holly			3.6	4.4
Rhizosen	Holly			4.3	5.0
SS-NB3	Spreckels			2.7	3.5
HH 41	Holly			3.2	3.8
USC-1	Union			2.7	3.2
USC-4	Union			2.8	3.5
USC-5	Union			2.9	3.6
USC-6	Union			3.4	3.9
Monohyk	Seedex			6.5	7.8
US H11	C562	C546	C36	3.4	4.1
Y731H8	"	"	C31/6	4.1	4.4
Y746H8	"	"	C46/2	3.7	4.0
Y749H8	"	"	C49	3.9	4.6
Y754H8	"	"	C54	3.9	4.8
R770H8	"	"	R70	4.2	4.9
R739H8	C562	C546	R39(C2)	4.2	5.0
Y639H8	"	"	C39	4.6	4.9
Y641H8	"	"	C91	4.5	4.9
Y652H8	"	"	C92	4.3	4.8
7903H8	C562	C546	903	3.2	3.7
7906H8	"	"	906	3.7	4.0
Y731H26	C309		C31/6	4.5	4.3
Y754H26	"		C54	4.3	4.0
Y746H26	C309		C46/2	3.1	3.4
7903H26	"		903	3.9	4.2
7906H26	"		906	3.8	4.1
Y731H24	C796-22	C309	C31/6	3.9	4.4
R739H24	"	"	R39(C2)	3.7	4.0
Y746H24	"	"	C46/3	3.6	3.9
Y731H13	"	C546	C31/6	4.0	4.4
Y731H20	C562	C309	C31/6	4.1	4.8
Y731H23	C306	C309	C31/6	4.3	4.8
Y731H27	C562	C796-22	"	4.3	4.5
Y731H72	C718		"	4.1	4.6
Y731H92	C796-22		"	4.3	5.0
Y731H99	796-6		"	4.4	4.8
Y731H66	766-23		"	4.6	5.4
Y731H70	766-62		"	4.5	5.2
Y731H87	C790-55		"	4.6	5.2
Y731H89	C790-68		C31/6	4.8	5.5
Y731H67	6767aa		"	4.3	5.0
Y731H76	6776aa		"	4.4	4.6
Y731H82	C310/6aa		"	4.3	4.6
Y731H96	C796aa		"	3.9	4.9

* = average of 24 to 31 times replicated in test

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1988
(Continued)

Variety	Description MS	T-O	Male	CT Grade 8/23	9/12
7906H67	6767aa		906	4.2	4.2
7906H76	6776aa		"	3.7	4.0
US H11	C562	C546	C36	3.3	3.9
Y746H3	C562		C46/2	3.3	3.8
Y746H13	C796-22	C546	"	3.6	3.9
Y746H20	C562	C309	"	3.7	3.9
Y746H23	C306	C309	"	3.4	4.0
Y746H72	C718		"	3.4	3.5
Y746H86	C790-55aa		"	3.4	3.6
Y746H108	6224aa		"	3.3	4.2
Y746H92	C796-22		"	3.1	3.4
Y746H33	827		C46/2	3.6	3.8
Y746H41	742-24aa		"	3.0	3.5
Y746H51	6833aa		"	3.5	3.9
Y746H65	766-23aa		"	3.4	3.5
Y746H70	766-62		"	3.0	3.1
Y746H67	6767aa		"	3.3	3.4
Y746H76	6776aa		"	3.3	3.2
Y746H82	C310/6aa		"	3.6	3.9
MM, OPEN-POLLINATED					
F82-36	C36			4.0	4.2
Y009	US 22/3			3.4	3.7
768	US 75			3.1	3.2
86-37	C37			3.8	3.3
F86-31/6	C31/6			4.8	5.6
Y731	Y731			5.5	6.2
R771	Y31Rz			4.3	4.8
R639	C39			4.4	5.1

Variety	Description MS	T-O	Male	CT Grade 8/23	9/12
Y739	C39			4.7	5.2
R739	R39(C2)			4.2	4.5
R739-6	C39/R-6			4.6	5.6
F86-91	C91			4.6	5.0
Y741	C91			4.7	5.4
86-46/2	C46/2			3.9	4.2
Y746	C46/2			3.9	4.1
R773	Y46Rz			4.5	5.1
Y749	C49			4.7	5.2
F86-92	C92			4.9	4.8
Y752	C92			4.8	4.9
R772	Y52Rz			4.6	4.8
Y754	C54			4.4	4.9
Y454	C54			4.2	4.6
Y747	Y47			4.4	4.5
R747	R47			4.6	4.5
Y748	Y48			4.3	4.6
Y756	Y56			4.5	5.0
R770	R70Rz			4.7	5.2
R703	R03(Italy)			7.1	7.8
R713	R13(CA & FC)			4.9	5.7
R720	R20(Ft Collins)			5.3	6.2
R718	F_3(Y54 x B.m.)			5.3	5.9
R721	BC_1F_2(C37 x B.m.)			4.2	5.0
R722	F_3(Y54 x B.m.)			4.2	4.9
R702	R02			4.6	5.7

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1988
(Continued)

Variety	Description MS	T-O	Male	CT Grade 8/23	9/12
MM, S^f, A:aa POPULATIONS					
5747	747aa x A			3.5	3.9
7903	903aa x A			3.9	4.3
7905	905(A,aa)			4.5	4.8
7907	907Rz(A,aa)			4.9	5.7
7908	908Rz(A,aa)			4.3	5.1
7909	909Rz(A,aa)			4.5	5.1
mm, S^f, A:aa POPULATIONS					
7743	C789/2			4.1	4.7
7755	C310/5			4.3	4.8
6756	C310/6			4.4	4.8
7756	C310/6			4.6	4.9
7767	767aa x A			4.1	4.5
7776	776aa x A			4.1	4.3
7790L	C790			3.5	4.2
7796	C796			4.2	4.3
7797	797(A,aa)			3.9	4.0
mm, S^f, Rz, A:aa POPULATIONS					
7850	RZM 850			4.3	4.9
7851	RZM 851			3.6	4.3
7852	RZM 852			3.7	4.4
7853	RZM 853			4.5	5.3
7854	RZM 854			4.1	4.5
7855	RZM 855			4.4	5.2
7860	RZM 860			4.2	4.9
7861	RZM 861			4.5	4.8
7862	RZM 862			4.3	5.2

Variety	Description MS	T-O	Male	CT Grade 8/23	9/12
mm, S^f LINES					
F82-546H3	C562	C546		3.6	3.4
5546H92	C796-22	C546		3.4	3.5
87-309H37	C306	C309		3.9	4.4
87-309H3	C562	C309		3.7	4.0
87-309H72	C718	C309		3.4	3.7
87-309H92	C796-22	C309		3.4	3.1
F82-546		C546		3.8	3.9
F82-562		C562		4.2	4.3
F82-562HO	C562			3.4	3.1
83-718		C718		3.3	3.7
85-306CMS	C306			4.2	5.1
87-309		C309		4.7	5.1
87-309CMS	C309			4.9	5.3
F85-796-22		C796-22		3.4	2.9
796-22CMS	C796-22			3.5	3.2
5502		NB 1		4.3	4.1
7766-8		766-8		4.3	4.7
7766-14		766-14		4.0	4.2
7766-23		766-23		5.1	6.5
7766-38		766-38		4.0	4.7
7766-44		766-44		4.1	5.0
7766-62		766-62		4.2	4.3
6762-17		762-17		3.7	2.9
6827		827		4.9	5.6
6796-6		796-6		4.0	4.1
6796-15		796-15		4.3	4.6
6796-28		796-28		4.0	4.0
F82-546H3	C562	C546		3.8	3.9

RHIZOMANIA EVALUATION AND SELECTION TRIALS

In 1988, four major set of trials to evaluate rhizomania resistant germplasm were planted: (1) Germplasm and hybrids were evaluated in Spence field trials planted from November to May to evaluate for yield without the effects of rhizomania and for reaction to bolting, PM, ERR, VY, etc. (2) Tests 3288 and 3388 were planted at Spence field in April. The trial area was fumigated with Telone and was found to be free of rhizomania. These two split-plot trials were grown under noninfested and infested disease treatments. (3) Test RZM 188-1 through 188-7 were planted in May in a field plot at the research station with a high level of rhizomania. Entries were from seed lots that were produced prior to 1988. (4) Tests RZM 288-1 through 288-5 and RZM 388-1 through 388-11 were planted in August under severe rhizomania infested conditions. Tests included entries from 1988 seed productions. Thus, seed produced in mid-1988 from selections made in late 1987 were evaluated.

When tested under non-rhizomania conditions, germplasm lines derived from selections for resistance to rhizomania were similar to the base material developed at Salinas. It does not appear that selecting for resistance within existing breeding lines or converting existing lines to resistance will necessarily or negatively influence yield or reaction to other diseases.

Selections for resistance to rhizomania made in 1987 continued to improve the level of resistance to rhizomania as measured by yield under sever conditions. Within populations and sources such as R39, R47, R20, etc., significant further improvement was achieved. Also, transfer of resistance or tolerance from Beta maritima continued to be successful.

Starting from a relatively susceptible germplasm base in 1984, the Salinas resistance program has developed a rather wide germplasm base with some degree of resistance or tolerance to rhizomania. Within this base are lines that owe their resistance to quantitative and/or qualitative types of resistance. Although we have not been able to measure exactly the degree of protection provided by these present levels of resistance, the situation now appears much brighter than it did just a few years ago. We believe that in an integrated approach for control of rhizomania that includes soil testing, date of planting, fumigation, resistant/tolerant cultivars, etc., that nearly normal sugarbeet yields can be achieved.

TEST 3288. NONINFESTED RHIZOMANIA INFESTED VS NONINFESTED EVALUATION OF GERMPLASM, SALINAS, CA., 1988

Split-block with 6 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: April 21, 1988
Harvested: October 11-12, 1988
Not Infested[1]/

Variety	Description[3]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters[2]/	Root Rot[2]/	Beets/ 100'[2]/	App. Purity
		Lbs	Tons	%	%	%	No.	%
7906	6235,6,7aa x A	10,139	33.69	15.07	0.0	0.0	138	79.4
7903H106	6232,3aa x 6903	9,872	31.03	15.93	0.0	0.4	136	82.4
Rizor-3	SES(1987)	9,773	30.41	16.11	0.2	0.2	143	81.1
Rhizosen	Holly(1/5/88)	9,768	30.73	15.91	0.0	0.0	128	81.6
7906H106	6232,3aa x 6235,6,7	9,679	31.25	15.52	0.0	0.0	129	81.1
Y639H8	F82-546H3 x Y539(C0)	9,424	29.42	16.02	0.0	0.0	142	83.3
R639H8	F82-546H3 x R539(C1)	9,286	29.42	15.79	0.0	0.0	146	82.0
R#Comp.	Blend R773,R771,R772	9,227	29.96	15.43	0.0	0.0	133	80.0
R639(C1)	Inc. R539(C1)	9,195	29.38	15.64	0.9	0.0	131	81.1
7906H8	F82-546H3 x 6235,6,7	9,191	31.84	14.43	0.0	0.2	140	79.9
7903	6903aa x A	9,143	29.76	15.39	0.0	0.0	139	80.4
7903H8	F82-546H3 x 6903	9,123	29.77	15.31	0.0	0.0	142	80.7
Y639(C0)	Inc. Y539(C39)	8,965	27.05	16.62	1.2	0.0	122	82.5
US H11	786442,546H3 x C36	7,807	28.92	13.56	0.0	0.0	140	79.2
Y#Comp.	Blend C46/2,C37,C31/6,C92	7,407	23.86	15.51	0.0	0.0	135	80.5
F82-546H3	82460,C562HO x C546	6,748	24.81	13.68	0.0	0.0	133	78.1
Mean		9,047	29.46	15.37	0.1	0.1	136	80.8
LSD (.05)		794	2.95	0.78	0.7	NS	7.7	1.6
C.V. (%)		7.6	8.70	4.40	503.8	741.3	6.9	1.8
F Value		11.1**	5.6**	9.2**	2.4**	1.6NS	5.6**	5.2**

[1]/Rhizomania infested and % loss data are summarized on the following page.
[2]/Means over both treatments.
[3]/7903 = MM, S^f, A:aa popn. 7906 = MM, S^f, A:aa popn segregating for Rz:rzrz. 6232, 3; 6235,6 = mm, S^f, A:aa popns segregating for Rz:rzrz.

TEST 3288. INFESTED RHIZOMANIA INFESTED VS NONINFESTED EVALUATION OF GERMPLASM, SALINAS, CA., 1988

Split-block with 6 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: April 21, 1988
Harvested: October 11-12, 1988

Variety	Description	Sugar Yield		Beet Yield		Sucrose		Raw J. App. Purity
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	
		Lbs/A	%	Tons/A	%	%	%	
R639(C1)	Inc. R539(C1)	9,419	-2.9	30.67	-4.8	15.37	1.6	82.2
7906	6235,6,7aa x A	9,398	7.4	32.56	3.4	14.44	4.1	79.7
7906H8	F82-546H3 x 6235,6,7	9,367	-1.9	32.22	-1.0	14.56	-1.0	80.3
Rizor-3	SES(1987)	9,271	5.1	29.20	4.2	15.93	1.1	80.8
R639H8	F82-546H3 x R539(C1)	9,234	0.3	30.72	-4.5	15.06	4.6	82.1
7903H106	6232,3aa x 6903	9,198	6.8	30.55	1.5	15.10	5.2	80.7
Rhizosen	Holly(1/15/88)	9,180	5.5	29.91	2.2	15.37	3.4	82.8
7906H106	6232,3aa x 6235,6,7	9,117	5.8	30.99	0.8	14.73	5.0	79.8
R#Comp.	Blend R773,R771,R772	9,040	2.1	29.85	0.4	15.18	1.5	79.8
7903	6903aa x A	9,034	0.6	29.91	-1.0	15.18	1.4	80.9
Y639(C0)	Inc. Y539(C39)	8,625	3.3	27.16	-1.2	15.90	4.3	82.2
Y639H8	F82-546H3 x Y539(C0)	8,621	8.3	28.48	3.2	15.19	5.2	81.9
7903H8	F82-546H3 x 6903	8,319	8.8	28.04	5.8	14.78	3.4	81.7
US H11	786442,546H3 x C36	7,864	-0.3	28.57	0.9	13.70	-1.1	80.0
Y#Comp.	Blend C46/2,C37,C31/6,C92	7,685	-4.8	25.76	-8.5	14.93	3.7	80.3
F82-546H3	82460,C562HO x C546	6,643	1.6	25.21	-2.2	13.07	4.0	76.8
Mean		8,751	2.9	29.36	-0.1	14.91	2.9	80.8
LSD (.05)		1,010	NS	3.51	NS	0.79	NS	1.9
C.V. (%)		10.0	342.3	10.40	6287.2	4.60	165.2	2.1
F value for varieties		9.4**	1.1NS	4.6**	1.1NS	10.4**	1.1NS	7.0**
F value for treatment		2.7NS	--	0.02NS	--	16.3**	--	0.2NS
F value for variety x virus		1.2NS	--	1.0NS	--	1.2NS	--	1.4NS

Note: See 3288 Noninfested.

TEST 3388. NONINFESTED EVALUATION OF RHIZOMANIA RESISTANT VARIETIES, SALINAS, CA., 1988

Split-plot with 8 replications
4 entries x 2 virus treatments
1-row plots, 44 ft. long

Planted: April 21, 1988
Harvested: October 12, 1988
Not Infested[1]/

Variety[3]/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot[2]/	Beets/ 100 ft. of Row[2]/	Raw J. App. Purity
		Lbs	Tons	%	%	No.	%
Rizor-3	SES(1987)	8,741	27.15	16.08	0.4	120	79.8
Rhizosen	Holly(1/5/88)	8,536	27.60	15.43	0.2	122	82.8
R739(C3)	RZM R639(C2)	7,737	25.53	15.15	0.2	114	80.5
US H11	(786442),546H3 x C36	7,096	26.24	13.48	0.2	125	79.2
Mean		8,027	26.63	15.03	0.3	120	80.6
LSD (.05)		559	NS	0.52	NS	6.4	2.1
C.V.(%)		6.7	6.10	3.30	294.0	7.5	2.5
F value		15.9**	2.6NS	39.1**	0.4NS	4.1*	4.7*

[1]/Rhizomania infested and % loss data are summarized in 3388 INFESTED.
[2]/Means over both treatments.

TEST 3388. INFESTED EVALUATION OF RHIZOMANIA RESISTANT VARIETIES, SALINAS, CA., 1988

Split-plot with 8 replications
4 entries x 2 virus treatments
1-row plots, 44 ft. long

Planted: April 21, 1988
Harvested: October 12, 1988
Inoculated with infested soil[1]/

Variety[2]/	Description	Sugar Yield		Beet Yield		Sucrose		Raw J. App. Purity
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss	
		Lbs/A	%	Tons/A	%	%	%	%
Rizor-3	SES(1987)	8,024	8.0	27.10	0.2	14.79	8.0	79.2
Rhizosen	Holly(1/5/88)	7,771	7.9	26.15	4.1	14.87	3.6	81.1
R739(C3)	RZM R639(C2)	7,678	0.1	26.35	-4.0	14.57	3.7	79.7
US H11	546H3 x C36	6,710	5.0	26.48	-1.5	12.67	5.7	78.5
Mean		7,546	5.3	26.52	-0.3	14.22	5.2	79.6
LSD (.05)		664	NS	0.00		0.60		2.0
C.V.(%)		8.5	216.8	7.30	3,776.7	4.00	105.4	2.5
F value varieties		19.5**	0.9NS	1.4NS		62.1**		7.1**
F value for treatments		3.0NS	--	0.01NS	--	5.8**	--	2.7NS
F value for variety x treatments		1.2NS		1.2NS	--	1.6NS	--	0.3NS

[1]/See 3388 NONINFESTED. Following bed preparation in a Telone fumigated field (soil samples negative for BNYVV), soil (positive for BNYVV) from an infested field was drilled into the beds preplant. Following thinning, the beets were sidedressed with infested soil. Cross ditches were used to keep water movement from treated to nontreated blocks. Following harvest, soil samples taken from infested treated plots were positive for BNYVV. The results of Tests 3288 and 3388 suggest that rhizomania infestation the first year does not cause severe and significant losses for root yield. However, significant reduction in sucrose % did occur. Thus as generally observed, the evidence of initial rhizomania infestation may not be in root yield and development of severe symptoms but in a reduction of sugar concentrations. The disease severity was not sufficiently intense to determine the relative degree of protection provided by these varieties against rhizomania.

TEST RZM 188-1. RHIZOMANIA EVALUATION OF HYBRIDS & GERMPLASM,
SALINAS, CA., 1988

32 entries x 4 reps, RCB
1-row plots, 16 ft. long

Planted: May 18, 1988
Harvested: October 20, 1988

Variety	Description[2]/	Acre Yield		Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Sugar	Beets					
		Lbs	Tons	%	No.	%	%	Rating
Rizor-3	SES(1987)	4,810	18.31	13.15	181	78.5	86.7	3.78
R739(C3)	RZM R639(C2)	4,259	15.17	14.05	179	80.8	82.2	3.61
Y731H106	6232,33aa x F86-31/6	3,957	15.82	12.50	153	79.6	85.3	3.93
Y746H115	6233aa x Y646	3,749	15.68	12.10	182	77.6	82.5	3.77
Rhizosen	Holly(1988)	3,652	16.63	11.00	175	77.7	82.5	3.98
7860	RZM 6233	3,617	15.35	11.73	187	80.0	85.4	3.80
R713	RZM R613(FC&CA)	3,581	12.77	14.02	181	82.2	82.9	3.91
Y746H114	6232aa x Y646	3,465	13.46	12.82	162	78.5	88.6	3.78
R739(FS-C2)	Inc. R639(FS-C2)	3,888	13.22	12.80	171	79.0	81.4	3.82
7906H106	6232,33aa x 6235,6,7	3,358	13.05	13.02	190	80.0	91.5	3.77
R703	RZM R603 Alba	3,170	12.18	13.00	192	78.7	86.5	4.31
7850	RZM 6232	3,137	12.61	12.40	200	78.0	85.6	4.09
R739H106	6232,33aa x R639	3,061	12.07	12.75	198	78.0	78.6	3.96
R720	RZM 6220(FC)	3,025	12.98	11.60	204	78.0	78.3	4.24
HH 8335	Hilleshog 8335	2,775	12.06	11.45	185	78.2	77.8	4.67
7903H106	6232,33aa x 6903	2,702	10.68	12.75	165	77.5	79.2	4.28
R718	RZM R618(Y54 x BM)	2,634	11.52	11.40	170	76.2	77.9	3.84
R722	F_3(Y54 x BM)	2,522	11.31	11.07	160	74.3	65.4	4.45
R739H8	F82-546H3 x R639	2,370	11.22	10.55	203	77.3	82.9	4.45
F86-31/6	Inc. C31/6	2,021	9.36	10.55	176	71.6	77.9	4.73

TEST RZM 188-1. RHIZOMANIA EVALUATION OF HYBRIDS & GERMPLASM, SALINAS, CA., 1988
(Continued)

Variety	Description[2]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
RH Z	Desprez(1988)	1,987	9.95	9.60	151	75.1	88.1	4.70
86-46/2	Inc. C46/2	1,809	8.08	11.10	182	74.6	79.4	4.70
RH-EU 5	F-M(4/88)	1,806	10.52	8.48	137	71.8	86.6	4.74
RH-EU 1	F-M(4/88)	1,806	9.92	8.93	181	70.3	87.2	4.67
RH-EU 4	F-M(4/88)	1,769	9.91	9.00	182	68.8	82.5	4.86
RH-EU 3	F-M(4/88)	1,702	10.43	8.07	164	66.2	78.1	4.66
Y781H8	F82-546H3 x F86-31/6	1,669	8.60	9.65	187	71.8	80.8	4.78
RH-EU 2	F-M(4/88)	1,509	9.04	8.27	181	69.7	74.9	4.70
6625	Betaseed(70331-2)	1,417	6.64	10.60	185	74.6	77.0	4.88
US H11	786442	1,187	7.54	7.55	175	65.1	78.9	4.89
Y746H8	F82-546H3 x 646	1,024	6.57	7.70	190	66.2	82.3	4.79
F82-546H3	C562HO x C546	990	5.14	9.82	164	71.2	77.9	4.98
Mean		2,623	11.49	11.05	178	75.2	81.7	4.33
LSD (.05)		815	2.86	1.56	NS	6.6	9.6	0.40
C.V. (%)		22.1	17.70	10.00	13.8	6.3	8.4	6.60
F value		12.1*	9.3**	11.5**	1.6NS	3.8**	2.1**	9.7**

Note: Planted in soil with high infestation of rhizomania. 1988 test is fifth successive crop under rhizomania conditions.

[1]/Rhizomania disease index. At harvest, roots were individually scored on a scale of 0 (immune) to 6 (dead): The 3 rating is classical "wine'glass" shaped roots; 4 = enlarged hypocotyl and crown but absence of tap root. Most roots at harvest were classified as 3, 4, or 5's.

[2]/RZM = mass selection for resistance to rhizomania.

TEST RZM 188-2. RHIZOMANIA EVALUATION OF LINES AND HYBRIDS, SALINAS, CA., 1988

16 varieties x 8 reps-RCB
1-row plots, 16 ft. long

Planted: May 18, 1988
Harvested: October 24, 1988

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease[1]/ Index
		Lbs	Tons	%	No.	%	%	Rating
Rizor-3	SES(1987)	4,910	18.49	13.24	193	80.5	83.8	3.56
7906	6235,6,7aa x A	4,588	18.29	12.57	164	80.1	82.8	3.46
Rhizosen	Holly(1/5/88)	4,231	17.24	12.16	178	83.0	81.9	3.96
R#Comp.	Blend R771,2,3	3,857	14.67	13.16	174	80.0	81.3	3.70
R639(C1)	Inc. R539(1)	3,838	13.97	13.69	154	82.3	82.3	3.46
7906H106	6232,3aa x 6235,6,7	3,590	14.60	12.34	165	79.7	83.2	3.82
7903H106	6232,3aa x 6903	3,326	13.42	12.40	154	78.8	78.7	3.92
Y639(C0)	Inc. Y539(C39)	3,148	11.81	13.34	146	81.8	78.4	4.23
7906H8	F82-546H3 x 6235,6,7	2,712	12.09	11.11	181	76.5	78.3	4.27
Y#Comp.	Blend C46/2,C31/6,C92	2,231	10.25	10.86	180	76.9	75.4	4.68
R639H8	F82-546H3 x R539(1)	2,188	9.99	10.91	165	76.8	77.2	4.51
Y639H8	F82-546H3 x Y539	2,041	9.95	10.20	150	76.6	73.7	4.70
7903	6903aa x A	1,577	7.80	10.04	152	74.9	75.3	4.94
7903H8	F82-546H3 x 6903	1,455	7.80	9.27	183	74.1	71.3	4.95
US H11	546H3 x C36	1,220	7.36	8.11	161	68.2	70.7	4.92
F82-546H3	C562CMS x C546	645	3.77	8.54	147	69.5	77.9	5.04
Mean		2,847	11.97	11.37	165	77.5	78.3	4.26
LSD (.05)		458	1.65	0.74	22	2.4	4.3	0.20
C.V. (%)		16.2	13.90	6.60	13.9	3.2	5.6	4.70
F value		61.5**	50.9**	44.3**	3.2**	24.3**	7.1**	64.7**

Note: [1]/See Test RZM 188-1.

TEST RZM 188-3. RHIZOMANIA EVALUATION OF NEAR-ISOGENIC Rz:rzrz LINES, SALINAS, CA., 1988

16 entries x 4 reps, RCB
1-row plots, 16 ft. long

Planted: May 18, 1988
Harvested: October 25, 1988

Variety[1]/	Description	Acre Yield Sugar	Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
Y739(C3)	RZM R639(C2)	4,753	17.24	13.80	179	81.4	83.9	3.34
7908	RZM 6236	4,687	18.59	12.55	190	77.9	84.7	3.30
7909	RZM 6237	4,513	17.28	13.00	185	80.0	85.6	3.61
Rizor-3	SES(1987)	4,386	16.84	13.02	196	78.6	85.4	3.52
R773	RZM 6261,2	4,019	16.35	12.35	179	78.0	90.7	3.59
R772	RZM 6257,8	3,726	14.22	13.10	170	80.1	83.7	3.63
R771	RZM 6259,60	3,591	14.51	12.35	198	78.0	90.1	3.84
Rhizosen	Holly(1988)	3,295	14.07	11.85	187	78.2	78.2	4.80
R721	RZM 6241-49(SB x BM)	2,414	9.70	12.50	171	75.8	74.0	3.82
F86-92	Inc. C92	2,101	9.01	11.65	181	76.3	74.8	4.69
U86-46/2	Inc. C46/2	1,661	7.89	10.40	173	76.0	73.4	4.87
5747	4747aa x A	1,604	9.19	8.75	192	69.8	77.4	4.97
7903	6903aa x A	1,581	7.85	10.15	171	75.5	76.8	5.01
F86-31/6	Inc. C31/6	1,550	7.79	9.80	176	68.1	80.4	4.89
HH 37	Holly	1,327	8.21	8.05	185	69.2	78.1	5.01
85-87	Inc. C37	1,093	5.50	9.95	198	70.8	74.2	4.99
Mean		2,894	12.40	11.45	183	75.9	80.7	4.21
LSD (.05)		815	2.77	1.19	0	4.9	7.2	0.37
C.V. (%)		19.8	16.00	7.30	14.5	4.6	6.3	6.10
F value		22.3**	20.2**	16.8**	4.1*	5.7**	5.0**	28.4**

Note: [1]/See Test RZM 188-1 and Tests RZM 288-4 & 388-4.

[1]/Near-isoline pairs are C92:R772, C46/2:R773, C31/6:R771, 5747:7908, and 7903:7909.

TEST RZM 188-4. EVALUATION OF SOURCES OF RHIZOMANIA RESISTANCE, SALINAS, CA., 1988

4 varieties x 8 reps, RCB
2-row plots, 16 ft. long

Planted: May 18, 1988[1]/
Harvested: October 25, 1988

Variety	Description[2]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	RJAP	Clean Beets	Disease Index
		Lbs	Tons	%	No.	%	%	Rating
R739(C3)	RZM R639(C2)	4,982	18.42	13.53	160	82.0	86.2	3.10
Rizor-3	SES(1987)	4,558	18.11	12.54	199	78.6	83.6	3.67
Rhizosen	Holly(1/5/88)	4,116	17.33	11.89	191	80.7	85.2	4.07
US H11	C546H3 x C36	1,112	7.54	7.39	187	69.1	72.2	5.03
Mean		3,692	15.35	11.34	184	77.6	81.8	3.96
LSD(.05)		394	1.40	0.67	18	3.5	2.8	0.10
C.V. (%)		10.3	8.80	5.70	9.6	4.4	3.4	2.50
F value		171.3**	120.0**	140.6**	7.0**	23.5**	44.1**	536.3**

Note: Also see Tests 1488, 3288, 3388 & RZM 288-2, 388-5 and other RZM tests.
[1]/Planted in field plot with high rhizomania infestation.
[2]/For tests planted prior to June 1, cycle 3 (C3) of R39 was grown. For tests planted after August 1, cycle 4 (C4) of R39 was grown.

TEST RZM 188-5. RHIZOMANIA EVALUATION OF C0:C1:C2:C3 SYNTHETICS OF Y39 AND Y47, SALINAS, CA., 1988

16 entries x 8 reps, RCB
1-row plots, 16 ft. long

Planted: May 18, 1988
Harvested: October 27, 1988

Variety	Description[1]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
R739(C3)	RZM R639(C2)	5,232	19.80	13.24	139	81.7	83.5	3.18
R739-6(C3)	RZM R639-6HS	5,053	20.35	12.43	139	80.3	85.8	2.90
R739(C2)	Inc. R639(C2)	4,770	18.52	12.86	136	81.9	84.2	3.22
Rhizosen	Holly Rz hybrid	4,637	19.08	12.14	162	81.5	84.5	3.79
R647(C2)	RZM R547(C1)	4,429	18.49	12.00	156	80.2	83.6	3.46
R739(CFS-C3)	RZM R639-FS	4,400	18.12	12.14	144	81.6	84.5	3.33
R747(C3)	RZM R647(C2)	4,382	18.24	12.04	145	80.9	85.6	3.11
R739-4(C3)	RZM R639-4HS	4,319	16.79	12.88	151	80.1	81.9	3.30
Rizor-3	Resistant check	4,271	17.68	12.13	168	78.7	81.6	3.59
R639(C1)	Inc. R539(C1)	4,123	15.64	13.15	140	81.2	82.1	3.51
R739-7(C3)	RZM R639-7HS	3,397	13.28	12.77	138	79.7	77.9	3.66
Y439(C0)	Inc. Y339	3,022	12.00	12.55	150	80.2	78.7	3.93
Y747(C0)	YR-ER-PMR Y547	2,886	12.95	11.09	125	78.4	79.3	4.13
Y547(C0)	YR-ER-PMR Y347	2,577	11.48	11.18	150	78.0	80.6	4.39
US H11	Susc. check	1,529	8.86	8.61	155	72.2	71.5	5.00
U86-37	Susc. check	1,525	7.59	9.93	146	73.1	75.3	4.90
Mean		3,784	15.56	11.94	147	79.4	81.33	3.71
LSD (.05)		536	2.00	0.67	21	2.2	4.51	0.26
C.V. (%)		14.3	13.00	5.60	14.6	2.9	5.60	7.00
F value		37.1**	31.5**	26.9**	2.0*	12.8**	6.0**	45.4**

Note: [1]/See Test RZM 188-1.

[1]/RZM = mass selection for resistance to rhizomania. C# = cycle of selection.

TEST RZM 188-7. RHIZOMANIA EVALUATION OF TX'S OF 6235, 6, 7aa x POPN-767
SALINAS, CA., 1988

32 entries x 2 reps, RCB
1-row plots, 16 ft. long

Planted: May 18, 1988
Harvested: October 25, 1988

Variety	Description[2]/	Acre Yield		Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Sugar	Beets					
		Lbs	Tons	%	No.	%	%	Rating
7767H101-7	6235-14aa x 6767	5,050	19.58	12.90	190	80.3	75.1	3.61
7767H101-9	6235-16aa x 6767	5,044	19.25	13.15	190	82.4	79.0	3.65
7767H101-10	6235-17aa x 6767	4,994	18.26	13.70	193	84.6	78.7	3.63
7767H101-14	6235-28aa x 6767	4,949	20.13	12.35	178	79.1	80.6	3.71
Rhizosen	Resist. check	4,338	17.94	12.10	159	80.9	84.8	3.93
7767H101-6	6235-12aa x 6767	4,082	17.50	11.75	187	81.2	77.8	4.15
7767H101-11	6235-21aa x 6767	4,038	19.40	10.60	181	77.8	78.1	3.83
7767H101-3	6235-5aa x 6767	3,880	16.05	12.10	175	79.0	73.3	3.68
7767H101-12	6235-23aa x 6767	3,810	15.76	12.20	175	79.5	76.3	4.12
7767H101-1	6235-1aa x 6767	3,771	15.31	12.25	165	78.4	76.5	4.22
7906H68	6767HO x 6235,6,7	3,633	15.17	11.90	187	81.4	76.8	3.91
7767H101-16	6235-34aa x 6767	3,336	15.44	10.90	168	73.6	78.8	4.02
7767H102-25	6236-9aa x 6767	3,270	14.15	11.95	134	77.3	88.1	4.43
7767H101-5	6235-10aa x 6767	3,269	14.00	11.55	165	78.0	74.5	3.96
7767H102-24	6236-8aa x 6767	2,984	14.65	10.20	209	74.1	86.4	4.16
7767H103-30	6237-14aa x 6767	2,952	12.05	11.95	175	80.3	68.6	4.09
7767H102-21	6236-5aa x 6767	2,951	13.24	11.35	160	83.7	76.1	4.20
7767H103-33	6237-17aa x 6767	2,890	12.26	11.55	165	79.1	70.1	4.19
7767H102-23	6236-7aa x 6767	2,785	12.66	11.00	165	75.0	75.0	4.35
7767H103-31	6237-15aa x 6769	2,684	11.38	11.80	178	77.3	70.8	4.36

TEST RZM 188-7. RHIZOMANIA EVALUATION OF TX'S OF 6235, 6, 7aa x POPN-767
SALINAS, CA., 1988
(Continued)

Variety	Description[2]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
7767H103-34	6237-18aa x 6767	2,577	11.96	10.60	162	76.7	71.6	4.40
7767H102-22	6236-6aa x 6767	2,573	11.38	10.95	184	76.6	73.0	4.45
7767H103-28	6237-12aa x 6767	2,520	10.35	12.05	175	76.4	76.9	4.61
7767H102-20	6236-4aa x 6767	2,439	11.81	10.25	200	74.7	78.5	4.89
7767H103-32	6237-16aa x 6767	2,355	9.91	12.00	168	75.0	71.6	4.29
7767H102-19	6236-3aa x 6767	2,316	12.40	9.25	187	70.0	79.7	4.68
7767H102-26	6236-10aa x 6767	2,276	10.94	10.30	171	69.2	73.9	4.64
7767H102-27	6236-11aa x 6767	2,195	9.89	11.10	140	75.2	75.9	4.57
7767H102-17	6236-1aa x 6767	2,101	11.96	8.80	184	74.7	75.3	4.65
7767H102-18	6236-2aa x 6767	2,075	10.44	9.85	193	70.3	75.7	4.81
7767H108-29	6237-13aa x 6767	1,844	10.32	9.05	125	76.7	74.3	4.36
US H11	Susc. check	1,112	6.47	8.60	159	71.0	64.3	5.07
Mean		3,159	13.81	11.25	173	77.2	76.1	4.24
LSD (.05)		1,377	5.40	2.22	NS	NS	8.8	0.57
C.V. (%)		21.4	19.20	9.70	11.8	5.7	5.7	6.70
F value		4.5**	3.3**	2.6**	1.7NS	1.5NS	2.5**	3.7**

Note: [1]/See Tests RZM 188-1; RZM 388-1; SPENCE 288, 788, & 3088.

[2]/6235-#'s are S_1 lines that segregate for A:aa & Rz:rzrz. 6236 & 6237-#'s are S_0 lines that segregate for A:aa & Rz:rzrz. 6767 = mm, S^f, A:aa popn tester.

TEST RZM 288-2. EVALUATION OF SOURCES OF RHIZOMANIA RESISTANCE, SALINAS, CA., 1988

4 varieties x 8 reps, RCB
2-row plots, 16 ft. long

Planted: July 22, 1988[1]/
Harvested: December 5, 1988

Variety	Description[2]/	Acre Yield Sugar	Beets	Sucrose	Beets/ 100'	RJAP	Clean Beets	Disease Index
		Lbs	Tons	%	No.	%	%	Rating
R839(C4)	RZM R739(C3)	1,814	7.35	12.33	180	74.0	77.2	3.71
Rhizosen	Holly(1/5/88)	1,398	6.31	11.07	185	74.7	77.9	4.28
Rizor-3	SES(1987)	1,394	5.91	11.76	201	71.1	73.5	4.05
US H11	C546H3 x C36	401	2.59	7.76	179	62.7	62.0	4.94
Mean		1,252	5.54	10.73	186	70.6	72.7	4.25
LSD(.05)		175	0.68	0.44	NS	2.2	6.1	0.16
C.V. (%)		13.5	11.80	3.90	13.9	3.1	8.2	3.60
F value		101.2**	78.7**	187.5**	1.2NS	51.3**	12.4**	93.4**

[1]/[2]/See Test RZM 188-4.

TEST RZM 388-5. EVALUATION OF SOURCES OF RHIZOMANIA RESISTANCE, SALINAS, CA., 1988

4 varieties x 6 reps, RCB
2-row plots, 13 ft. long

Planted: July 21, 1988[1]/
Harvested: November 30, 1988

Variety	Description[2]/	Acre Yield Sugar	Beets	Sucrose	Beets/ 100'	RJAP	Clean Beets	Disease Index
		Lbs	Tons	%	No.	%	%	Rating
R839(C4)	RZM R739(C3)	2,273	9.77	11.63	139	73.8	72.4	3.03
Rizor-3	SES(1987)	2,075	8.92	11.65	175	72.4	67.6	3.36
Rhizosen-1	Holly(1/5/88)	1,898	8.68	10.92	155	75.3	70.7	3.33
US H11	C546H3 x C36	502	3.71	6.72	145	62.7	60.8	4.03
Mean		1,687	7.77	10.23	154	71.1	67.9	3.44
LSD(.05)		271	0.79	1.16	18	4.2	4.0	0.29
C.V. (%)		13.1	8.30	9.20	9.8	4.9	4.8	6.90
F value		79.6**	109.8**	37.4**	6.6**	16.3**	14.7**	18.8**

[1]/[2]/See Test RZM 188-4.

TEST RZM 288-3. RHIZOMANIA EVALUATION OF C0:C1:C2:C3:C4 SYNTHETICS OF Y39 AND Y47
SALINAS, CA., 1988

16 entries x 8 reps, RCB
1-row plots, 16 ft. long

Planted: July 22, 1988
Harvested: December 5, 1988

Variety	Cycle/ Description[1]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
R839(C4)	C4	1,971	7.86	12.55	182	74.7	78.1	3.73
R876	Y31Rz-type	1,784	7.35	12.14	195	74.9	79.4	3.85
R739(C3)	C3	1,718	6.94	12.38	178	73.9	75.3	3.56
8911	909Rz-type	1,665	7.07	11.76	176	72.9	75.6	3.74
R647	C2	1,656	6.73	12.31	186	74.6	76.5	3.79
R847	C4	1,652	6.69	12.30	181	75.0	77.8	3.63
R820	C3 FC-#'s	1,635	7.27	11.23	177	70.9	78.6	3.59
R747	C3	1,624	6.57	12.34	198	74.8	82.0	3.67
R875	Y54Rz-type	1,570	6.45	12.14	192	74.6	72.7	3.74
R739(C2)	C2	1,466	6.18	11.80	185	74.0	78.1	3.73
R639	C1	1,411	5.77	12.21	164	73.0	76.0	3.78
Y439	CO R39 source	1,111	4.65	11.93	182	72.2	70.1	4.01
R818	RZM(SB x BM)	1,005	5.40	9.31	185	65.9	65.9	3.89
Y547	CO R47 source	966	4.38	10.94	179	72.6	75.9	4.22
U86-37	Susc. check	515	2.63	9.73	189	68.0	70.0	4.73
US H11	Susc. check	513	3.04	8.45	166	64.3	65.2	4.67
Mean		1,391	5.94	11.47	182	72.3	74.8	3.90
LSD (.05)		179	0.66	0.51	NS	2.1	6.5	0.24
C.V. (%)		13.0	11.20	4.50	13.8	3.0	8.8	6.30
F value		47.4**	42.6**	45.9**	1.1NS	19.6**	4.2**	16.5**

[1]/See test RZM 388-6.

TEST RZM 288-4. RHIZOMANIA EVALUATION OF NEAR-ISOGENIC Rz:rzrz LINES
SALINAS, CA., 1988

32 entries x 4 reps, RCB
1-row plots, 16 ft. long

Planted: July 22, 1988
Harvested: December 6, 1988

Variety[1]/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
Y839(C4)	RZM R739(C3)	2,395	9.74	12.23	165	74.6	84.5	3.40
8909	RZM 7909	2,284	9.46	12.07	157	73.0	80.5	3.66
R873	RZM R773	2,060	7.93	12.93	178	76.2	83.0	3.45
R871	RZM R771	2,018	8.13	12.43	156	74.3	84.7	3.60
8911	RZM 7239	1,899	7.80	12.10	165	73.1	81.5	3.59
R876	RZM 7259	1,880	7.55	12.45	179	74.6	87.4	3.85
Rhizosen	Holly(1988)	1,818	7.70	11.80	184	77.6	86.2	3.91
R820	RZM R720(FC)	1,734	8.01	10.80	160	70.7	81.2	3.56
8908	RZM 7908	1,716	7.45	11.50	159	73.2	81.4	3.62
R875	RZM 7258	1,707	6.91	12.35	192	76.2	79.9	3.53
R813	RZM R713(FC+CA)	1,680	6.59	12.68	170	75.0	79.4	3.51
8910	RZM 7238	1,678	7.55	11.10	150	69.8	74.4	3.85
R878	RZM 7261	1,618	6.65	12.20	160	75.2	74.4	3.83
R877	RZM 7257	1,605	6.27	12.77	154	73.8	79.0	3.66
R874	RZM R774	1,591	6.82	11.68	159	72.5	78.3	3.56
Rizor-3	SES(1987)	1,443	6.23	11.52	189	70.3	75.6	4.01
R803	RZM R703(Alba)	1,382	5.80	11.88	176	74.3	79.3	3.91
R872	RZM R772	1,372	5.99	11.25	153	74.7	76.6	3.58
R821	RZM R721(SB x BM)	1,135	4.95	11.43	154	69.2	65.5	3.83
R818	RZM R718(SB x BM)	1,083	5.84	9.27	173	68.4	74.6	3.72

TEST RZM 288-4. RHIZOMANIA EVALUATION OF NEAR-ISOGENIC Rz:rzrz LINES
SALINAS, CA., 1988
(Continued)

Variety[1]/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
R879	RZM 7263	1,025	4.30	11.82	160	73.7	75.7	4.15
F86-31/6	Inc. C31/6	929	4.33	10.55	157	70.8	75.0	4.70
R824	RZM 7241-2	909	4.09	11.02	167	70.5	67.3	4.16
R722	F_3(Y54 x BM)	904	4.97	9.18	151	68.1	69.6	4.08
R825	RZM 7243-7(SB x BM)	877	3.85	11.32	170	74.0	66.3	3.90
F86-92	Inc. C92	870	4.09	10.65	142	71.3	73.1	4.59
7903	6903aa x A	836	3.99	10.48	154	72.1	73.2	4.72
Y754	Inc. Y654	833	3.95	10.48	146	72.5	66.3	4.53
U86-46/2	Inc. C46/2	810	3.64	11.10	160	72.9	66.4	4.58
5747	4747aa x A	735	4.01	9.15	178	68.8	66.0	4.55
U86-37	Inc. C37	453	2.45	9.32	154	68.2	76.1	4.77
US H11	C546H3 x C36	446	2.83	7.80	153	65.3	66.6	4.92
Mean		1,366	5.93	11.23	163	72.3	75.9	3.98
LSD (.05)		367	1.31	1.17	NS	5.0	12.4	0.28
C.V. (%)		19.2	15.70	7.40	15.8	4.9	11.7	5.00
F value		16.2**	16.9**	8.7**	0.9NS	2.5**	2.2**	20.8**

[1]/See tests RZM 188-3 & 388-4. Near-isoline pairs are C37:R874:R879, Y54:Y875, C31/6:R871:R876, C92:R872:R877, C46:R873:R878, 5747:8908:8910, 7903:8909:8911 in order of recurrent parent: 2RZM BC_1F_2:RZM BC_2F_1. R821(C48), R824, R825, R818, & R722 (C50) involve sugarbeet x B. maritima (see test RZM 388-11).

TEST RZM 388-1. RHIZOMANIA EVALUATION OF TX'S OF 6235, 6, 7aa x POPN-767
SALINAS, CA., 1988

30 entries x 2 reps, RCB
1-row plots, 13 ft. long

Planted: July 21, 1988
Harvested: December 1, 1988

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Sugar	Beets					
		Lbs	Tons	%	No.	%	%	Rating
7767H101-7	6235-14aa x 6767	2,138	8.26	12.90	184	74.9	77.1	3.81
7767H101-10	6235-17aa x 6767	2,109	9.33	11.30	173	71.0	73.1	3.83
7767H101-6	6235-12aa x 6767	2,103	8.80	11.95	173	74.0	68.3	3.90
7767H101-11	6235-21aa x 6767	2,077	8.26	12.60	161	77.5	75.4	3.86
7767H101-3	6235-5aa x 6767	2,026	8.61	11.75	161	73.4	68.5	3.66
7767H101-12	6235-23aa x 6767	1,989	8.26	12.05	153	73.7	75.6	3.96
7767H102-24	6236-8aa x 6767	1,918	8.22	11.65	165	74.1	68.9	4.17
7767H101-14	6235-28aa x 6767	1,899	7.72	12.30	180	73.3	67.5	4.47
7767H101-5	6235-10aa x 6767	1,875	7.90	11.85	153	71.4	63.7	4.03
7767H102-25	6236-9aa x 6767	1,829	8.26	11.15	199	70.1	74.2	4.07
7767H101-1	6235-1aa x 6767	1,786	6.82	13.05	165	73.6	60.2	4.00
7767H103-30	6237-14aa x 6767	1,778	7.18	12.45	165	73.8	71.8	4.09
7767H101-16	6235-34aa x 6767	1,760	7.36	11.65	180	75.6	65.9	4.05
7767H103-32	6237-16aa x 6767	1,737	7.18	12.10	173	72.2	59.7	4.24
7767H102-20	6236-4aa x 6767	1,708	7.36	11.50	180	71.1	73.6	4.24
7767H103-33	6237-17aa x 6767	1,684	6.64	12.65	161	74.6	65.8	4.23
7767H101-9	6235-16aa x 6767	1,646	7.00	11.75	161	72.5	68.4	4.24
7767H103-28	6237-12aa x 6767	1,553	6.64	11.55	165	73.3	51.9	4.18
7767H102-26	6236-10aa x 6767	1,517	6.93	10.90	188	74.2	60.6	4.24
7767H102-18	6236-2aa x 6767	1,452	6.28	11.45	165	74.2	72.2	4.30

TEST RZM 388-1. RHIZOMANIA EVALUATION OF TX'S OF 6235, 6, 7aa x POPN-767
SALINAS, CA., 1988
(Continued)

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
7767H102-27	6236-11aa x 6767	1,373	6.28	10.95	157	74.2	63.3	4.36
7767H103-31	6237-15aa x 6767	1,358	5.74	11.85	146	71.5	61.5	4.39
7767H102-21	6236-5aa x 6767	1,351	6.28	10.50	169	74.9	65.0	4.34
7767H102-19	6236-3aa x 6767	1,338	6.68	10.05	149	72.2	70.3	4.50
7767H103-29	6237-13aa x 6767	1,333	6.28	10.60	161	70.9	69.0	4.39
7767H102-23	6236-7aa x 6767	1,301	6.10	10.70	176	69.0	63.3	4.49
7767H102-22	6236-6aa x 6767	1,199	5.39	11.10	184	71.3	59.4	4.48
7767H103-34	6237-18aa x 6767	1,150	5.74	9.95	165	65.5	59.6	4.42
7767H102-17	6236-1aa x 6767	985	4.67	10.55	146	71.9	60.6	4.58
US H11	786442	537	2.98	9.00	123	69.6	53.6	4.95
Mean		1,617	6.97	11.46	166	72.7	66.3	4.22
LSD (.05)		720	2.60	1.47	NS	NS	11.5	0.42
C.V. (%)		21.8	18.30	6.30	12.0	3.8	8.5	4.90
F value		2.3*	2.2*	3.3**	1.2NS	1.4NS	2.7**	3.5**

Note: See footnotes for test RZM 188-7.

TEST RZM 388-2. RHIZOMANIA EVALUATION OF LINES AND HYBRIDS, SALINAS, CA., 1988

16 varieties x 6 reps, RCB
1-row plots, 13 ft. long

Planted: July 21, 1988
Harvested: December 1, 1988

Variety	Description[1]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index[1]/
		Lbs	Tons	%	No.	%	%	Rating
Rhizosen	Holly(1/5/88)	2,275	9.80	11.60	162	75.6	78.9	3.72
Rizor-3	SES(1987)	2,264	9.45	11.83	167	70.4	72.1	3.66
7906H106	6232,3aa x 6235,6,7	2,129	9.07	11.77	144	75.5	77.4	3.42
R#Comp.	R871,R872,R873,R874	2,096	8.91	11.75	146	73.3	79.9	3.18
7906	6235,6,7aa x A	1,953	8.98	10.85	143	72.3	71.8	3.23
R639(C1)	Inc. R539(C1)	1,610	6.46	12.45	121	75.0	74.7	3.25
Y639(CO)	Inc. Y539(CO)	1,590	6.47	12.27	135	74.7	75.4	3.49
7903H106	6232,3aa x 6903	1,499	6.64	11.28	133	73.6	71.9	3.69
7906H8	F82-546H3 x 6235,6,7	1,479	6.88	10.73	147	72.6	71.7	3.89
R639H8	F82-546H3 x R539(C1)	1,296	6.11	10.57	135	71.1	70.2	3.83
Y#Comp.	C46/2,C31/6,C92,C37	1,117	5.27	10.57	148	71.0	67.9	4.16
Y639H8	F82-546H3 x Y539(CO)	1,116	5.57	10.08	148	70.6	69.4	4.35
7903	6903aa x A	1,066	5.27	10.07	134	69.8	66.7	4.41
US H11	C546H3 x C36	914	5.21	8.62	153	67.5	70.8	4.41
7903H8	F82-546H3 x 6903	805	4.37	9.25	128	73.1	65.4	4.67
F82-546H3	C562HO x C546	595	3.51	8.42	117	64.1	74.5	4.70
Mean		1,488	6.75	10.76	141	71.9	72.4	3.88
LSD (.05)		292	1.09	0.92	22	4.5	NS	0.37
C.V. (%)		17.1	14.00	7.40	13.7	5.5	12.6	8.30
F value		26.7**	25.3**	14.2**	2.9**	3.6**	1.3NS	15.3**

Note: See test RZM 188-2.

1/R#Comp. segregates for Rz:rzrz. 7906, 6232, 6233 segregate for Rz:rzrz. Corresponding hybrids between 7903 vs 7906 are differentiated by Rz.

TEST RZM 388-4. RHIZOMANIA EVALUATION OF NEAR-ISOGENIC Rz:rzrz LINES
SALINAS, CA., 1988

30 entries x 4 reps, RCB
1-row plots, 13 ft. long

Planted: July 21, 1988
Harvested: November 30, 1988

Variety[1]/	Description	Acre Yield		Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index
		Sugar	Beets					
		Lbs	Tons	%	No.	%	%	Rating
R871	RZM R771	2,283	9.31	12.25	140	73.8	70.1	3.18
Y839(C4)	RZM R739(C3)	2,245	9.34	12.10	163	75.4	70.5	3.02
R873	RZM R773	2,238	9.34	12.00	157	75.7	74.6	3.31
8908	RZM 7908	2,170	9.78	11.10	138	73.6	72.9	3.40
Rhizosen	Holly(1988)	2,166	9.51	11.38	161	76.0	69.3	3.43
8909	RZM 7909	2,143	9.69	11.07	142	72.8	68.2	3.39
R874	RZM R774	2,115	9.33	11.32	130	74.1	73.7	3.12
R876	RZM 7259	2,107	8.80	11.98	136	74.6	75.1	3.27
Rizor-3	SES(1987)	2,093	8.78	11.90	173	74.4	69.0	3.50
R820	RZM R720	2,057	9.94	10.32	138	71.1	70.3	3.29
8910	RZM 7238	2,036	9.34	10.82	126	71.9	71.2	3.46
R875	RZM 7258	2,020	8.71	11.60	119	74.5	73.2	3.35
8911	RZM 7239	1,878	8.17	11.48	128	74.1	66.8	3.44
R878	RZM 7261	1,868	8.22	11.35	146	74.9	62.7	3.63
R877	RZM 7257	1,713	7.54	11.35	134	72.4	68.4	3.54
R872	RZM R772	1,585	7.45	10.60	142	72.5	70.2	3.44
R825	RZM 7243-7	1,295	5.76	11.23	117	71.6	55.6	3.80
Y754	Inc. Y654	1,277	5.53	11.57	128	74.5	57.4	4.36
R821	RZM R721	1,218	5.39	11.25	128	69.4	53.9	3.89
R824	RZM 7241-2	1,205	5.30	11.38	130	71.1	58.6	3.70

TEST RZM 388-4. RHIZOMANIA EVALUATION OF NEAR-ISOGENIC Rz:rzrz LINES
SALINAS, CA., 1988
(Continued)

Variety[1]/	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index
		Lbs	Tons	%	No.	%	%	Rating
F86-31/6	Inc. C31/6	1,164	5.47	10.57	142	71.9	64.9	4.39
R879	RZM 7263	1,129	4.76	11.88	153	72.4	61.7	3.58
F86-92	Inc. C92	1,050	4.85	10.80	111	71.8	67.9	4.31
R722	F_3(Y54 x BM)	1,035	5.39	9.45	144	69.8	50.8	4.18
R818	RZM R813	1,034	6.46	8.02	130	65.4	58.5	3.65
7903	6903aa x A	958	4.65	10.32	142	73.9	59.7	4.51
86-46/2	Inc. C46/2	928	4.31	10.82	128	71.7	58.2	4.22
5747	4747aa x A	750	4.49	8.30	138	66.5	58.9	4.24
86-37	Inc. C37	682	3.57	9.55	153	68.4	62.3	4.28
US H11	C546H3 x C36	611	4.04	7.63	146	65.7	58.4	4.49
Mean		1,568	7.11	10.85	139	72.2	65.1	3.71
LSD (.05)		303	1.24	0.99	29	3.8	9.4	0.43
C.V. (%)		13.8	12.40	6.50	15.2	3.8	10.3	8.30
F value		26.5**	23.5**	11.2**	1.7*	4.4**	4.1**	8.7**

[1]/See tests RZM 288-4 & 188-3. Near-isoline pairs are C37:R874:R879, Y54:Y875, C31/6:R871:R876, C92:R872:R877, C46:R873:R878, 5747:8908:8910, 7903:8909:8911 in order of recurrent parent: 2RZM BC_2F_2:RZM BC_2F_1. R821(C48), R824, R825, R818, & R722 (C50) involve sugarbeet x B. maritima (see test RZM 388-11).

TEST RZM 388-6. RHIZOMANIA EVALUATION OF C0:C1:C2:C3:C4 SYNTHETICS OF Y39 AND Y47
SALINAS, CA., 1988

24 entries x 6 reps, RCB
1-row plots, 13 ft. long

Planted: July 21, 1988
Harvested: November 30, 1988

Variety	Cycle/ Description[1]/	Acre Yield		Sucrose	Beets/ 100	Raw J. App. Purity	Clean Beets	Disease Index
		Sugar	Beets					
		Lbs	Tons	%	No.	%	%	Rating
R839(C4)	C4 R39	2,290	10.04	11.40	270	72.3	78.9	3.07
R873	C46Rz	2,242	9.66	11.68	252	73.2	75.4	3.21
R847	C4 R47	2,201	9.69	11.33	267	74.2	79.3	3.04
R871	C31Rz	2,137	8.98	11.93	234	73.8	72.9	3.17
R813	C4 FC&CA	2,132	9.14	11.72	230	71.7	72.1	3.10
R820	C3 FC=Rhizoc.	2,070	10.18	10.15	244	69.1	68.4	3.28
Rhizosen	Holly Rz hybrid	2,054	9.53	10.77	253	75.1	74.0	3.35
R747	C3 R47	2,030	9.15	11.12	237	74.4	80.0	3.64
Rizor-3	Resist. check	1,994	8.95	11.00	276	69.1	73.4	3.48
R839-6	C4 R39-6HS	1,934	8.56	11.30	243	72.6	70.5	3.12
R647	C2 R47	1,901	8.68	10.85	267	73.4	77.3	3.16
R739(C3)	C3 R39	1,879	8.14	11.45	247	72.2	73.3	3.03
R803	C4 Alba	1,827	8.08	11.27	228	72.1	68.5	3.42
R839(C4-FS)	C4 R39-HS sel.	1,716	7.48	11.37	240	72.6	75.4	3.07
R839-7	C4 R39-7HS	1,716	7.49	11.47	256	70.8	71.3	3.30
R739(C2)	C2 R39	1,666	7.39	11.23	201	73.3	72.5	3.15

TEST RZM 388-6. RHIZOMANIA EVALUATION OF C0:C1:C2:C3:C4 SYNTHETICS OF Y39 AND Y47
SALINAS, CA., 1988
(Continued)

Variety	Cycle Description[1]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100	Raw J. App. Purity	Clean Beets	Disease Index
		Lbs	Tons	%	No.	%	%	Rating
R839-4	C4 R39-4HS	1,635	7.84	10.38	264	68.4	74.9	3.03
Y439	CO R39 source	1,533	6.44	11.92	212	74.0	73.5	3.19
R639	C1 R39	1,523	6.50	11.72	214	73.0	73.5	3.32
Y747	CO YR-ER-PMR Y47	1,274	5.99	10.58	212	71.6	74.8	3.38
R818	RZM(Y54 x BM)	1,183	7.00	8.43	225	63.4	65.6	3.23
Y547	CO R47 source	1,114	5.39	10.32	207	70.9	73.1	3.63
U86-37	C37 susc. check	660	3.95	8.30	246	64.8	71.7	3.58
US H11	Susc. check	551	3.79	7.38	196	60.6	63.2	4.27
Mean		1,719	7.84	10.79	238	71.1	73.1	3.30
LSD (.05)		292	1.04	0.95	37.62	2.7	7.4	0.37
C.V. (%)		14.9	11.60	7.70	13.80	3.4	8.9	9.90
F value		20.4**	23.3**	12.1**	3.0**	13.5**	2.3**	4.4**

1/See tests RZM 188-5 & 288-3.

TEST 388-11. RHIZOMANIA EVALUATION OF LINES WITH RESISTANCE FROM B. MARITIMA
SALINAS, CA., 1988

12 entries x 6 reps, RCB
1-row plots, 12 ft. long

Planted: July 21, 1988
Harvested: November 29, 1988

Variety	Description[1]/	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Raw J. App. Purity	Clean Beets	Disease Index
		Lbs	Tons	%	No.	%	%	Rating
R875	Y54Rz	1,764	6.68	13.27	230	74.8	72.8	3.37
R874	C37Rz	1,681	6.81	12.35	239	73.8	74.1	3.21
R818	3 RZM(Y54 x BM)	1,191	5.83	10.33	203	67.1	56.2	3.43
R821	2 RZM(C37*2 x WB41,2)	1,179	4.93	12.13	237	71.0	56.8	3.24
R826	RZM(C37*3 x WB42)	1,169	4.88	12.02	249	69.7	55.9	3.53
R827	RZM(WB42 x C37*3)	1,119	4.61	12.10	247	69.5	63.2	3.17
R824	RZM(C37*3 x WB41)	1,015	4.13	12.33	208	72.4	55.8	3.69
R722	C50,F_3(Y54 x BM)	986	4.86	10.15	208	68.1	58.5	3.88
R825	RZM(C37*3 x WB42)	963	4.15	11.63	247	69.3	60.4	3.45
Y754	Y54,susc. SB parent	924	3.83	12.13	187	73.0	69.4	4.22
U86-37	C37,susc. SB parent	492	2.33	10.45	231	66.6	58.4	4.28
5967	B. maritima, WB52	273	1.23	11.18	274	55.9	37.4	3.16
Mean		1,063	4.52	11.67	230	69.3	59.9	3.55
LSD (.05)		262	1.08	0.94	37	2.8	9.5	0.34
C.V. (%)		21.3	20.70	7.00	14.1	3.5	13.8	8.20
F value		20.3**	17.8**	8.2**	3.3**	25.1**	8.3**	10.7**

[1]/RZM = mass sel. for resistance to rhizomania. WB52 from Denmark & similar to WB41 & 42. R821 = C48.

SUGARBEET RESEARCH

1988 Report

Section B

U.S. Agricultgural Research Station
Beltsville, Maryland

Dr. L. D. Owens, Plant Physiologists
Dr. C. S. Wozniak, Tissue Culturist/
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Dr. J. B. Philbrick, Molecular Biologist

The research was supported in part by funds provided through the Beet Sugar Development Foundation (Project 150).

CONTENTS

Gene-Transfer Technology Development for Sugarbeet

Lowell Owens

The problem of developing a routine and efficient method for obtaining transgenic sugarbeets has two parts, the cell or tissue culture part and the mode of transferring selected genes. Since all gene-transfer techniques developed thus far are successful only at a low frequency, i.e., only a few of the target cells are actually transformed, it is usually necessary to maximize the number of "useful" target cells. By "useful" target cells is meant those plant cells which are capable both of being transformed and of regenerating into whole fertile plants. Our efforts to maximize the number of useful target cells has dealt mainly with two systems, leaf disc and suspension cell cultures. The mode of gene transfer that we have experimented with is that mediated by Agrobacterium tumefaciens.

Leaf Disc System -- L. Owens and C. Wozniak. For maximizing the induction of useful target cells in a leaf disc system we started with the highly regenerative genotype, REL-1, and a culture system reported by J. Saunders and his colleagues (Crop Sci. 26:1240-1244, 1986). To increase the production of regenerative callus per plate we employed multiple discs platings. This necessiated substituting a richer medium (RV) that we had previously found superior for production of adventitious shoots from sugarbeet petiole explants (Freytag, et al., 1988, Plant Cell Reports 7:30-34). The production of morphogenic callus and subsequently of somatic embryos and shoots was the same on a plate basis whether five 7-mm discs were plated per dish or ten 4-mm discs. The latter size, however, was more easily obtained from leaves of cultured shoots. Discs were transferred to fresh medium on the 14th and 28th day and final data recorded on about the 48th day. We found that the slight amount of disc-edge callus remaining on plates from which discs were transferred on the 28th day proceeded to grow rapidly and produced as many morphogenic structures as did callus attached to the transferred leaf discs. Production of somatic embryos and shoots was further enhanced by use of a gellan gum for solidifying the medium instead of agar. By combining these modifications, from 80 to 100 somatic embryos and shoots per plate were obtained in 48 days of culture.

Suspension Cell Transformation -- C. Wozniak and L. Owens. We have used regenerative callus produced in the above fashion to initiate suspension cell cultures. Cocultivation of these cells with agrobacteria carrying appropriate vectors has succeeded in producing cells that appear to be transformed as indicated by activity of a reporter gene. The reporter gene is B-glucuronidase synthase (GUS). The frequency of putative transformation, however, is erratic and requires further research.

Vector Construction -- J. Philbrick and L. Owens. Because we employ A. tumefaciens to actually accomplish the transfer of selected genes to sugarbeet cells, it is useful to consider appropriate strain and vector combinations. We found that a wild-type strain carrying a tumor-inducing

(Ti) plasmid of the L,L-succinamopine type was much more efficient for inducing tumors on sugarbeet tissue than one carrying an octopine type plasmid. Differences in tumor-inducing efficiencies is likely due to differences in their respective virulence (vir) genes. Consequently, we have constructed a binary plasmid appropriate for use with a disarmed (non-tumorous) mutant of the highly virulent L,L-succinamopine type Ti plasmid (pEHA101). The binary plasmid (pGT100) carries chimeric plant-expressible genes for kanamycin resistance and GUS positioned between T-DNA (transferred-DNA) border sequences. This plasmid has been mated into Agrobacterium strains carrying either octopine or L,L-succinamopine type vir plasmids for testing on sugarbeet.

ABSTRACTS OF PUBLISHED ARTICLES

A. H. Freytag, S. C. Anand, A. P. Rao-Arelli, and L. D. Owens. 1988. An improved medium for adventitious shoot formation and callus induction in Beta vulgaris L. in vitro. Plant Cell Reports 7:30-34. Six sugarbeet (Beta vulgaris L.) lines (GWI-24, SPB-11, MonoHy 55, SMS-1, EL45 and FC607) were tested for regeneration. Shoot cultures were initiated in vitro from naked, sterilized embryos obtained from mature seed. Excised petioles from cultured shoots were plated on Gamborg's B5 medium and four modified Murashige and Skoog (MS) media. A medium containing MS inorganic salts supplemented with 0.4 mg/l N^6-benzyladenine, 0.1 mg/l indole-3-butyric acid, ten vitamins and six amino acids, termed RV, was superior for both adventitious shoot and callus formation. Callus was observed only on RV medium and only on petioles that did not develop adventitious buds directly. Rooting of regenerated shoots and development of complete plants was accomplished by transfer to Gamborg's B5 medium with 5 mg/l indole-3-butyric acid as the sole phytohormone. The complete process of regeneration through adventitious shoot production took from 4 to 6 weeks from explants to rooted plants. The callus that formed on nonorganogenic petioles was regenerative when transferred to fresh RV medium. Regeneration from callus occurred mainly by shoot organogenesis but also by somatic embryogenesis at a low frequency.

SUGARBEET RESEARCH

1988 REPORT

Section C

Crops Research Laboratory, Agricultural Research Service
U.S. Department of Agriculture, Fort Collins, Colorado

Dr. R. J. Hecker, Geneticist
Dr. S. S. Martin, Plant Physiologist
Ms. J. A. Narum, Research Chemist, BSDF
Dr. E. G. Ruppel, Plant Pathologist
Dr. E. G. Schweizer, Weed Scientist

Cooperation:

Colorado State University Experiment Station

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CONTENTS

Publications

Abstracts of Papers Published or Approved for Publication and Germplasm Registrations.

Hecker, R. J. and E. G. Ruppel. Sugar beet breeding lines and cultivars developed for rhizoctonia root rot resistance. Bio. and Cul. Tests for Control of Pl. Dis. Am. Phytopath. Soc. (Accepted 12/20/88)

Genetic resistance is being developed in sugarbeet, *Beta vulgaris*, against a root rot fungus, *Rhizoctonia solani*. The ten most resistant germplasms are compared with the only available resistant cultivars (four). Means of 3 years data from inoculated field tests at Fort Collins, Colorado, show that the cultivars are about 33% as resistant as our most resistant germplasms. Nine of the germplasms have been released and registered. The tenth is a release candidate.

Lasa, J. M. and R. J. Hecker. 1988. Registaration of sugarbeet parental lines AD-1, AD-2 and AD-3. Crop Sci. 28:1041-1042.

Three multigerm pollinator sugarbeets (AD-1, AD-2, and AD-3) were developed and released by CSIC in Spain. The lines were autotetraploid and genetically heterogeneous. In a joint project between CSIC and ARS-USDA to develop monogerm hybrids that would facilitate mechanized culture in Spain and increased sucrose productivity in both countries, these three parental lines were identified as superior specific combiners with four ARS-USDA CMS monogerm lines. This search involved a potential of 480 hybrids and 4 years of field testing in both countries. These three parental lines are being registered as parental lines, not necessarily limited to use as pollinators of the four ARS-USDA CMS lines that are in process of release and registration.

Lasa, J. M., I. Romagosa, R. J. Hecker and J. M. Sanz. 1989. Combining ability in diploid and triploid sugarbeet bybrids from diverse parents. J. Sugar Beet Res. 26:10-18.

In the process of developing sugarbeet hybrids among diploid U.S. CMS monogerm lines and diploid and tetraploid European pollinators, a fixed set of 120 hybrids involving 32 female lines and 15 pollinators were evaluated over six environments. General (GCA) and specific combining ability (SCA) estimates were derived independently for diploid and triploid hybrids. There was a masking effect of tetraploid pollinators of diploid CMS lines. The relative importance of the pollinator vs. the female lines was different in diploid than in triploid hybrids. No significant female GCAs were detected for the triploid hybrids, whereas GCA estimates for the same CMS lines derived from diploid hybrids were generally significant. Higher environmental stability was detected among triploid than among diploid hybrids. The use of public monogerm CMS lines crossed to open pollinated pollinators was found to be an acceptable way to readily start a monogerm sugarbeet hybrid breeding program.

Martin, S. S. Analysis of constitutive and induced phenolics of Beta vulgaris by high performance liquid chromatography. (Approved by ARS for publication in J. Sugar Beet Res.)

Study of the flavonoid phytoalexins betagarin and betavulgarin, compounds induced in leaves of *Beta vulgaris* by infection with *Cercospora beticola*, has been

limited by lack of a sufficiently sensitive analytical procedure. Reverse phase high performance liquid chromatography effectively separated the phytoalexins; optimal analyses required gradient elution by mixtures of acetonitrile and 3% (v/v) acetic acid. Modifications of the elution gradient enabled examination of the simple phenolic acids and aldehydes that are found constitutively in many leaf extracts, often increasing with disease or other stress. Other gradient changes provided the best conditions for examination of compounds such as the ferulic amides found in sugarbeet seeds. These constitutive coimpounds were identified by comparison with standards, where available, or with literature retention data and ultraviolet absorption spectra (obtained on-line with a photodiode array detector).

Ruppel, E. G. 1988. Fusarium species associated with diseased sugarbeet. Phytopathology 78:1563.

Sugarbeet roots showing Fusarium yellows symptoms were collected from six western states. Isolations on Komoda's *Fusarium*-selective medium yielded 48 isolates of seven *Fusarium* spp. Besides *F. oxysporum* f. sp. *betae*, the reported cause of Fusarium yellows, an isolate of *F. acuminatum* from Colorado, two Texas isolates of *F. avenaceum*, an Oregon isolate of *F. sambucinum*, and a nonsporulating "Roseum" type were pathogenic on sugarbeet seedlings, all causing foliar yellowing, wilt, root necrosis, and eventual death. When roots of 3-mo-old plants were wound-inoculated with the seedling pathogens, only *F. o. betae* and *F. acuminatum* induced typical yellows symptoms. All isolates caused some necrosis of secondary roots and apparently-arrested necrotic lesions on the tap root, but no plant death. In both pathogenicity tests, all pathogenic and nonpathogenic isolates were reisolated from surface-disinfested roots 2 mo after inoculation.

Papers Published Since Abstracted in Previous Report.

Casas, A., J. M. Lasa, R. J. Hecker and I. Romagosa. 1989. In vitro multiplication of primary trisomic sugarbeets. J. Sugar Beet Res. 26:19-25.

Hecker, R. J. and E. G. Ruppel. 1988. Registration of Rhizoctonia root rot resistant sugarbeet germplasm FC 709. Crop Sci. 28:1039-1040.

Hecker, R. J. 1988. Pollen characteristics of diploid and tetraploid sugarbeet. J. Sugar Beet Res. 25:55-62.

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EFFECT OF ROOT SIZE ON COMBINING ABILITY FOR SUCROSE PRODUCTION (BSDF Project 200)

R. J. Hecker

This is the first year of a 2-year field test of effect of root size on combining ability for several component characters of sucrose production. The objective is to provide definitive data to detect or measure any relationship of root size and combining ability. This information is basic to breeding hybrids.

GW674, a heterogeneous multigerm open pollinated cultivar adapted to the irrigated plains, was the source population from which selections were made for large root and small root (minimum 6 cm diameter). About 30 large and 30 small roots were selected from about 300 plants within each of 10 small blocks grown at optimum fertility at the Colorado State University Agronomy Research Center. The selected roots were analyzed for sucrose content. About 50 large and 50 small roots were selected as follows: (1) large and small roots, respectively, were at least one standard deviation heavier or lighter than the mean of the source population; and (2) sucrose was within one-half of a standard deviation of the source mean, except that the sucrose mean of the final 50 large and 50 small roots was the same as the GW674 mean. This control of sucrose was necessary to prevent a confounding effect of sucrose content. These 50 large and 50 small roots were allowed to interpollinate in separate isolations, and the seed was harvested in bulk. This seed was planted in two blocked selection strips for three more cycles of selection similar to the first cycle. In each cycle the final 50 large and 50 small selections had to have the same sucrose mean as GW674. In the 4th cycle isolation plots, five diverse CMSs (three single-cross hybrids and two inbreds) were interplanted and harvested separately as combining ability testers. In the same year a random sample of GW674 roots was used as the pollinator of the same five CMS testers.

In 1988 the 15 top-cross hybrids were grown in a field test, along with GW674 and the high and low weight selection cycles 1 through 4. The design was a randomized complete block with six replications of 1-row plots, 20 ft long and 22 inches apart. The experiment was planted 4/14/88; stands were adequate. Hail occurred 6/9/88 (10% defoliation) and 7/26/88 (40% defoliation). Harvest was 10/6/88. Standard sucrose and thin juice purity analyses were made. Pressed juice was analyzed for amino nitrogen, sodium, and potassium.

Tables 1 and 2 show performance of the selected and source populations. The selection objectives were accomplished marginally through four cycles. The 4th cycle small root selection was significantly smaller than the large root selection. However, it was not different than the source. Sucrose was not held constant, the large root selection had less sucrose than the small root selection and the source. Purity and recoverable sucrose were unchanged by selections. Amino N was lower in heavy roots, Na was higher in heavy roots, and potassium was reduced in heavy roots.

Table 1. Performance of selections for low and high root weight and the source population, 1988.

Population	Rt. wt. kg/plot		Sucrose %		Purity %		Recoverable suc. (kg/plot)	
Source	14.3		15.2		89.0		1.671	
LSD (0.5)	2.2		0.7		3.7		0.338	
	low	high	low	high	low	high	low	high
1st cycle	13.9	15.6	16.1	13.9	85.4	90.3	1.547	1.722
2nd cycle	15.1	14.9	15.7	14.2	91.4	93.0	1.953	1.786
3rd cycle	14.6	16.6	15.9	14.2	91.0	90.8	1.887	1.923
4th cycle	15.1	17.2	15.1	14.4	91.8	90.3	1.900	1.991

Table 2. Performance of selections for low and high root weight and the source population, 1988. Data without parentheses are mg/100 ml pressed juice; data in parentheses are g/100 g sucrose.

Population	Amino N		Na		K	
Source	60 (3.0)		26 (1.4)		160 (8.1)	
LSD (.05)	14 (0.7)		9 (0.5)		18 (0.9)	
	low	high	low	high	low	high
1st cycle sel.	51 (2.5)	34 (1.9)	23 (1.1)	30 (1.7)	147 (7.1)	137 (7.6)
2nd cycle sel.	49 (2.4)	35 (1.9)	22 (1.1)	37 (2.0)	151 (7.4)	128 (6.9)
3rd cycle sel.	57 (2.8)	34 (1.8)	17 (0.8)	34 (1.9)	161 (7.8)	132 (7.1)
4th cycle sel.	57 (2.9)	35 (1.4)	28 (1.4)	36 (2.0)	155 (7.9)	138 (7.4)

Tables 3 and 4 show the averages of the five tester hybrids for each selection and the source. These means indicate a tendency toward favorable CA in the small root selections for root yield, sucrose, recoverable sucrose, and Na. Large root tends to have more favorable CA for purity, amino N, and K.

Table 3. Means of a set of five hybrids (combining ability testers) resulting from each of three pollinators.

Pollinator	Rt. Wt. kg/plot	Sucrose %	Purity %	Recoverable suc. (kg/plot)
4th cycle low rt.wt.	15.86	15.3	90.2	1.94
4th cycle high rt.wt.	15.20	14.2	91.7	1.79
Source population	14.98	15.1	91.4	1.86
LSD (.05)	1.00	0.3	1.7	0.15

Table 4. Means of a set of five hybrids (combining ability testers) resulting from each of three pollinators. Data without parentheses are mg/100 ml pressed juice; data in parentheses are g/100 g sucrose.

Pollinator	Amino N	Na	K
4th cycle low wt. sel.	50.1 (2.52)	25.7 (1.31)	147.3 (7.39)
4th cycle high wt. sel.	31.9 (1.75)	36.5 (2.03)	110.7 (6.03)
Source population	45.0 (2.29)	25.2 (1.30)	144.4 (7.34)
LSD (0.5)	6.1 (0.32)	4.0 (0.25)	8.2 (0.43)

From these preliminary data, it appears that there is no direct relation between root size and CA, and that small roots may have CA as good or better than large roots when sucrose is similar and both are from the same source.

The second year of field testing will be done in 1989, after which a complete combining ability partition and analysis will be done and reported.

RHIZOCTONIA ROOT ROT RESEARCH AND DEVELOPMENT OF GENETIC RESISTANCE IN SUGARBEET (BSDF Project 202)

1988 Field Research on Rhizoctonia Root Rot of Sugarbeet.--R. J. Hecker and E. G. Ruppel.

The field research in this project was conducted on the Colorado State University South campus on a land area restricted to our rhizoctonia root rot research. Our ARS rhizoctonia research project involves cooperative inputs from both the BSDF and Colorado State University. We are pleased to be able to lead this three-way cooperative research effort.

The 1988 field experiments were planted on an area that had been in barley for the previous 3 years. This was the site of our inoculated *Rhizoctonia* nursery in 1984. In 1988, no indigenous rhizoctonia root rot occurred before inoculation. Hence, the dense population of *Rhizoctonia* in the soil in 1984 essentially had been abated by the intervening 3 years of barley culture. All germplasm evaluation and selection experiments were planted in one-row plots, 6.1 m (20 ft) long and 56 cm (22 in) apart. Experiments were planted May 13 and thinned June 8-13. Dry, ground, barley-grain inoculum of *Rhizoctonia solani* (R-9) was banded at 12 or 19 g/6.1 m (20 ft) over each row with a tractor-mounted four-row granule applicator. Experiments involving highly resistant germplasm received the higher rate of inoculum, whereas experiments with more susceptible germplasms received the lower rate. Inoculation was done July 14, and our standard sprinkler irrigation regime was used to moisten and activate the inoculum.

Roots in all experiments were lifted September 19-23 and individually rated for rot. Disease index (DI) ratings were made on a scale of 0 to 7, with 0 = no evidence of infection and 7 = plant dead. The percentage of healthy roots were those with DIs of 0 and 1, those roots showing no active infection. The roots with DIs 0 through 3 also were analyzed as a class; these roots were sufficiently sound and large to be recovered in a commercial harvest. The epiphytotic of root rot in our 1988 rhizoctonia experiments was moderately severe and provided good evaluations of all germplasms tested.

Germplasm Development and Improvement for Rhizoctonia Root Rot Resistance.-- R. J. Hecker and E. G. Ruppel.

Sugarbeet losses to rhizoctonia root rot are increasing on a national scale. The disease is present in most beet growing areas, including the Red River Valley where it is increasing significantly. The increased incidence of this disease in most beet growing areas is due to several factors: (1) shortened crop rotations, (2) increased use of alternate host crops between beet crops, (3) cultivation practices that increase soil-crown contact, and (4) increased use of some hybrid varieties that are highly susceptible. There are no labeled chemical controls for this disease. Hence, adequate rotation, cultural practices, and tolerant hybrids are the only methods of control.

The objectives of this project are: (1) development of sugarbeets resistant to root rotting strains *Rhizoctonia solani* in genetic backgrounds that will facilitate incorporation of resistance into hybrid varieties; (2) development of new knowledge about the pathogen, host-pathogen interactions, and interactions of pathogen with cultural practices and other crops; and (3) biocontrol.

During 1988, we registered our most resistant germplasm to date, FC 709. This is a multigerm, self sterile, N cyto, leaf spot resistant, non-O-type that is vigorous and heterogeneous for most characteristics. FC 709 is a population from which pollinators might be derived, or which can serve as a source of genes for resistance. Our current emphasis is the introgression of resistance into breeding lines that are resistant to curly top or leaf spot and/or are CMS, monogerm, and O-type. Examples of these germplasms in various stages of development and our most resistant lines are shown in Table 1.

Table 1. Means for rhizoctonia root rot assessment of germplasms in various stages of resistance development; 1988 inoculated field test.

Entry	Germplasm	Disease[1] index	Healthy[1] roots (%)	Harvestable[1] roots (%)
517	FC 709; MM[2]	1.6	56	96
528	FC 712; MM	1.9	59	86
542	FC 707/2;MM	1.9	55	85
519	871039HO; mm[2], OT[2]	1.9	56	83
543	FC 703/5	2.2	41	83
516	FC 710; mm	2.2	39	79
541	(FC 703/5 x Resist, fodder beet), 1 cy. sel.	2.6	28	77
510	FC 708; mm, OT	2.6	33	82

Entry	Germplasm	Disease[1] index	Healthy[1] roots (%)	Harvestable roots (%)
544	FC 702/7	2.7	35	68
537	4 cy. rh. sel. (high combining lines)	2.7	33	65
520	5 cy. rh. sel. (USSR MM pool)	2.8	25	71
513	FC 708 CMS[2]; mm, OT	2.9	22	75
558	3 cy. rh. sel. (high LSR[2])	3.1	33	62
546	Rh. sel. (high sucrose lines)	3.1	20	56
525	4 cy. rh. sel. (Polish mm)	3.3	27	52
522	2 cy. rh. sel. (CTR[2] x Rhiz. resist)	3.5	26	44
524	2 cy. rh. sel. (FC 607 CMS x FC 708)	4.0	15	47
551	ACH 184; resist. comm. hyb.	4.2	12	32
529	3 cy. rh. sel. (FC 609 x FC 708)	4.3	15	40
534	2 cy. rh. sel. (C718 x FC 708)	4.6	10	44
535	2 cy. rh. sel. (C718 CMS x FC 708)	4.6	12	38
523	2 cy. rh. sel. (FC 607 x FC 708)	4.9	6	34
554	Monohikari; susc. comm. hyb.	6.3	2	11
507	Susceptible check	6.2	2	8
509	FC 703; resist. check	3.6	20	54
508	FC 705/1; high resist. check	2.1	49	80
	LSD (0.5)	0.8	NA	NA

[1]Disease index = 0 (no disease) to 7 (all plants dead); healthy roots = no infection or small arrested lesions; harvestable roots = roots sufficiently large and sound to be included in a grower's harvest; [2]MM = multigerm; mm = spot resistant; CTR = curly top resistant.

The germplasms listed in Table 1 are about 20% of our developmental lines, about half of which are in the seed production phase. Our next release candidate is entry 519, which currently is being reindexed for O-type. It is a monogerm that is vigorous and has potential for good general combining ability. Entry 522 is also a release candidate; although its DI is 3.49, it is our most rhizoctonia resistant line that also has some curly top resistance (1988 CT index = 4.7 vs 546H3 = 3.7).

Some of our moderately rhizoctonia resistant lines, as well as miscellaneous entries, are shown in Table 2.

Table 2. Rhizoctonia resistance assessment of moderately resistant breeding lines and miscellaneous entries; 1988 inoculated field test.

Entry	Description	Disease index	Healthy roots (%)	Harvestable roots (%)
439	FC 609	5.42	10	24
440	FC 609 CMS	5.59	4	18
441	1 cy. rh. sel. (rh. resist. mm OT x C718)	3.99	16	53
442	1 cy. rh. sel. (C718 CMS x rh. mm OT)	3.97	23	46
443	USH11	5.47	7	15
444	Rhizosen-1; rhizomania resist	5.36	4	21
445	Y731; Salinas rhizom. resist	6.11	3	10
446	Y739; Salinas " "	5.62	8	13
447	R739(C3); Salinas " "	5.70	9	15
448	R771; Salinas " "	5.71	9	18
449	R703; Salinas " "	5.87	5	10
450	R713; Salinas " "	5.77	3	9
451	R720; Salinas " " from Ft. Collins rhizoc lines	2.83	42	67
452	R722; Salinas	6.15	3	7
453	AD-3; 4x Spanish pollinator	3.79	0	14
454	AD-2; 4x " "	5.94	1	10
455	AD-1; 4x " "	4.50	11	27
463	SP85700-0; E. Lansing smooth root	5.16	10	18
468	F-1008; Fargo low resp.	6.39	4	8
469	F-1007; " " "	6.15	4	12
434	Susceptible check	5.79	2	14
436	FC 703, resist. check	2.76	36	64
435	FC 705/1, high resist check	1.60	64	91
	LSD (.05)	1.07	NA	NA

It is of interest that all of the rhizomania resistance lines were rhizoctonia susceptible except entry 451, which was developed from Ft. Collins germplasms. The relatively good rhizoctonia resistance of entry 453 and 455 also is of interest. These parental lines were registered in 1988 as high combining pollinators; they were bred originally from Netherlands and Polish sources, respectively.

Development of rhizoctonia resistance has been slow and, at times, frustrating due to the multigenic nature and low heritability of this character. Nevertheless, we have made significant progress and have accumulated, in certain germplasms, genes that do provide resistance to the root rotting strains of *R. solani*. We are hopeful that our in vito techniques (see Project 760) will facilitate a more positive identification of resistant genotypes, which, in effect, will increase the heritability and make selection more efficient. In theory, if heritability were 1 ($h^2 = 1$) and a suffieiently large number of plants could be evaluated, only one recombinant segregating generation would be needed to select the most resistant individuals. However, other important production

characteristics, e.g., combining ability, sucrose content, etc., are also of vital concern. Hence, our germplasm development efforts are designed to augment the programs of commercial breeders whose objective is development of *Rhizoctonia*-resistant hybrids that are highly productive.

Selection for Rhizoctonia Root Rot Resistance--R. J. Hecker and E. G. Ruppel.

About half of our rhizoctonia inoculated field nursery is dedicated each year to selection for improved resistance. In 1988, we had 32 entries in the selection area, a total of about 45,000 plants preinoculation. Inoculation was done July 14, and selections were made about October 1. An average of 8% of the plants was selected per entry. Selection primarily was based on relative freedom of disease. We know from previous experiments that the heritability (h^2) of resistance is about 0.25. Hence, only 25% of the variability we select is due to genes for resistance; the other 75% is environmental variability. This is the reason breeding progress for resistance has been slow. This also inspires our search for a more precise method of identifying resistant genotypes (see Project 760).

The 3600 roots selected in October 1988 will be planted in greenhouse or field isolations in the winter and spring of 1989 for seed production to start another cycle of selection or to combine with other resistant sources. The roots selected from the inoculated nursery probably all carry some *R. solani*, which is unable to grow in the 5° C storage environment. Roots transplanted to pots in the greenhouse in early January typically have little root rot develop during seed production. Similar roots planted in the greenhouse in April usually will develop serious root rot, and only a few plants may produce seed. The difference between January- and April-planted roots probably is due to higher soil temperature in the pots. Roots transplanted into field isolations in April usually have 40-80% survival, depending on the resistance level of the roots.

To apply greater selection pressure, especially to the more resistant lines, we often inoculate roots when they are transplanted into field isolations. Two cc of ground barley-grain inoculum is distributed around the root and covered with about 2.5 cm of soil. The roots then are irrigated or individually watered to moisten and enhance the growth of *Rhizoctonia*. The intensity of infection from this inoculation is somewhat variable, depending on the location and the weather. Opportunity exists to rogue plants during seed production; however, disease symptoms usually do not develop until after plants have flowered and contributed to the pollen cloud. Of course, selection still can be done on the females. We have not measured the effect of this inoculation on genetic gain, but our empirical evidence indicates that it has contributed to increased resistance.

Two precautions about mother root inoculation should be noted: (1) relatively susceptible plants may be all or nearly all killed; and (2) the isolation plot will be contaminated, which may result in serious loss the following year if susceptible roots are planted.

Survival of *Rhizoctonia solani* in Fallow Field Soil.--E. G. Ruppel.

Rhizoctonia solani, the cause of a serious root rot in sugarbeet, can survive for long periods in organic debris. Western soils, however, are very low in organic content (<2% in Colorado). Little information is available on survival of the pathogen in infected root debris or soil at various depths. Such knowledge may help determine management strategies for control of the disease.

A field site was prepared normally for planting, and plots were marked off in a randomized complete block design with five replicates; the site has been fallow for several years. Three-month-old sugarbeet roots, inoculated 1 month earlier and showing symptoms of rot, were cut in half longitudinally through the lesion area. Each half was placed in an envelope made from nylon screen. These envelopes were buried at 5-, 10-, and 20-cm in the field. No irrigation was applied to the field. Beginning at 2 months after burial and at bimonthly intervals, envelopes were exhumed and the contents were examined and assayed for *R. solani* on a *Rhizoctonia*-selective medium (Ko & Hora's). Soil samples taken from the immediate area surrounding the buried envelopes also were assayed for the fungus. Soil temperatures at the 5- and 20-cm depths were monitored daily, and weekly air temperatures and precipitation records were obtained from Colorado State University. Pathogenicity tests were conducted on sugarbeet with a random sample of *R. solani* isolates from the assays.

After 2 months, root halves buried at 5 cm still were intact, although almost completely blackened with rot. At 10 and 20 cm, root shape was no longer discernable; only nondescript, blackish organic residue remained. After 4 months, root shape of halves buried at 5 cm still was discernable, but, after 6 months, shallow-buried halves were mummified and beginning to break down. The more rapid breakdown of roots at the 10- and 20-cm depths possibly was due to higher soil moisture at these depths than at the surface and to the action of anaerobic bacteria present in deeper soil profiles.

Results of the assays of root debris are shown in Fig. 1. Of the remnant root debris, 20% of the 5-cm samples yielded the fungus at both the August and October dates. By December, no 5-cm sample yielded the pathogen. No debris sample buried at 10 cm yielded the fungus in August or October, but the pathogen was recovered from 40% of the 20-cm samples in December. This increase in colonized debris may reflect increased soil moisture (from precipitation) in September (Fig. 2) and November (not shown). Assays of root debris from the 20-cm depth showed that 20% of the samples contained the fungus at each bimonthly harvest.

Fig. 1. Rhizoctonia isolations from buried, infected sugarbeet root debris

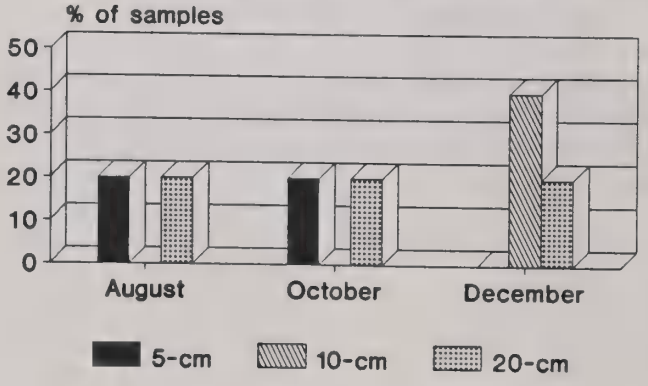
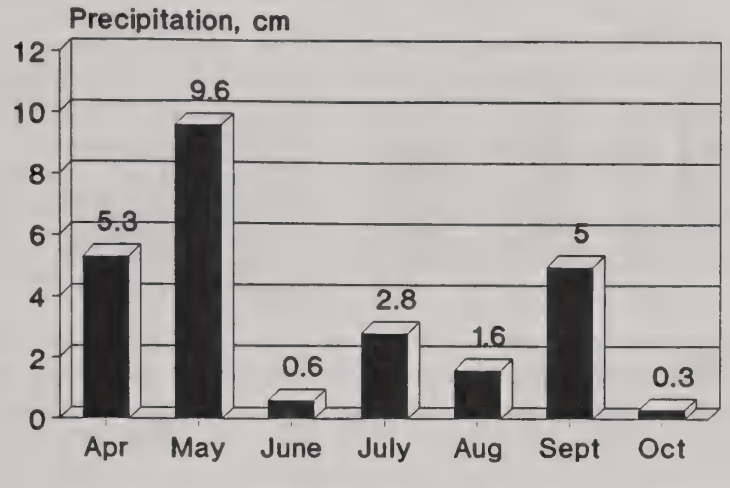


Fig. 2. Monthly precipitation at Fort Collins, April-October 1988.



Results of the assays of soil adjacent to the buried envelopes of root debris are shown in Fig. 3. The population density of the fungus as colony-forming units per gram of soil (cfu/g) was quite high in surface soil at the 2-month sampling but decreased significantly by October. By December, only 1.3 cfu/g were detected. Population densities at the 10- and 20-cm depths, although variable among sampling dates, tended to remain more constant than those in surface soil. All random isolates of *R.* solani from the assays were pathogenic and highly virulent in sugarbeet in greenhouse tests with 3-month-old plants.

Fig. 3. Rhizoctonia isolations from fallow soil at three depths.

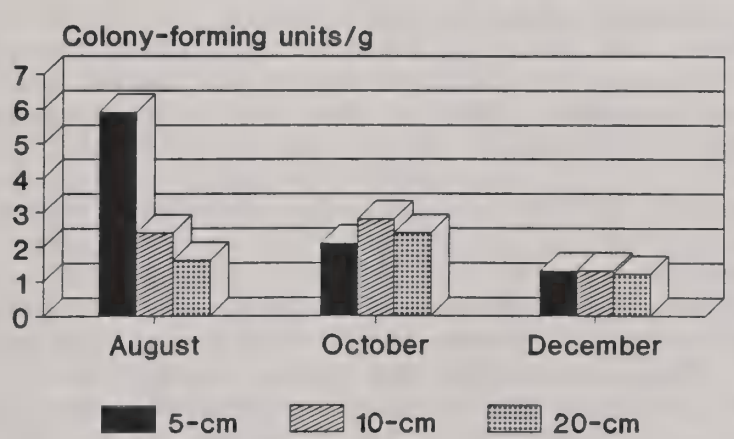
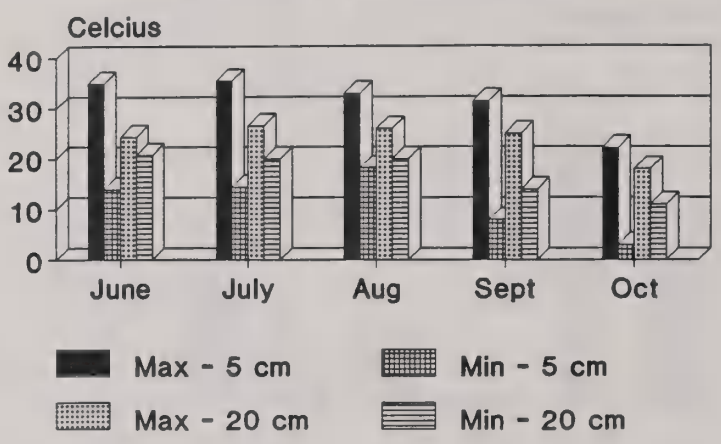


Fig. 4. Soil temperatures at Fort Collins, June-October 1988.



Although definite conclusions cannot be drawn until the experiment is repeated over at least 2 more years, it appears that the population density of *R. solani* decreases rapidly in relatively dry, fallow surface soil, and that in deeper soil profiles, lower but somewhat stable populations persist for at least 6 months. The reason for the rapid decline of the fungus in the upper soil profile undoubtedly was due to the high soil temperatures (35-36 C; Fig. 4) that occurred in June through September. In the deeper profiles, lower temperatures (16-26 C) and higher soil moisture were more favorable to pathogen survival.

Effect of Growing Different Crops on the Population Density of Rhizoctonia solani in Soil.--E. G. Ruppel.

Little is known about the effect of rotation crops on the populations of *Rhizoctonia solani*, the cause of sugarbeet root rot, in soil. Observations indicate that severe root rot can occur when beets are not rotated, or when beets follow alfalfa in rotation. Small grains and corn are recommended to precede sugarbeet in rotation schemes.

Two experiments were conducted to determine the effect of various crops on the population density of *R. solani* in soil. In the first test, we grew alfalfa, barley, corn, and resistant and susceptible sugarbeet in 15-cm-diameter pots of pasteurized soil infested with a very low concentration of *R. solani* inoculum. After 1, 2, and 4 months of growth, plants were harvested and soil from each pot was assayed on a *Rhizoctonia*-selective medium (Ko & Hora's). The pots of soil were left in the greenhouse for an additional 2 months when the soil assays were repeated. A randomized complete block design was used with four replicates.

The possibility that other organisms on or in seed might influence our results led to the second test in which surface-disinfested seed of alfalfa, barley, and resistant sugarbeet were placed on agar in petri dishes. After germination, noncontaminated germlings were transferred aseptically to sterile test tubes

containing sterilized moist soil to which inoculum of *R. solani* had been added. After 14 days, seedlings were removed and the soil from each tube was assayed for *Rhizoctonia* on the selective medium. Six replicates were used in a randomized complete block design.

In the first test, population densities of the fungus increased rapidly over time with the growth of corn and both the susceptible and resistant sugarbeet lines. In barley soil, the population density stayed the same for 2 months and then decreased. In alfalfa, surprisingly, the population density was quite low, increased slightly by 2 months, but then decreased between 2 and 4 months. In aseptic culture, *Rhizoctonia* population densities almost were identical for alfalfa, barley, and resistant sugarbeet soils.

The great increases in *Rhizoctonia* population density in sugarbeet soil probably was due to the increase in colonized, rotting root tissue. The increase in *Rhizoctonia* population density in corn is unexplained, but may be due to the fungus colonizing sloughed corn roots. The confusing picture of predisposition of root rot by alfalfa was not explained by this study. From previous field studies in which nitrogen regimes had no effect on the severity of root rot, we know that predisposition is not due to nitrogen fixation by alfalfa. The study did support field observations that monoculture of sugarbeet can lead to great increases in inoculum potential for subsequent beet crops.

Biocontrol Potential of an Alkaline-Tolerant Isolate of Trichoderma harzianum.--*E. G. Ruppel.*

Trichoderma harzianum is a known biocontrol agent of the root-rotting fungus *Rhizoctonia solani*. The agent is favored by moist, acid soils, but does persist at very low population densities in western calcareous soils of high pH. Earlier, we hypothesized that the presence of the agent in alkaline soils may indicate genetic variability for alkaline tolerance. In selections from over 200 isolates of *Trichoderma*, one isolate of *T. harzianum* was obtained that grew and sporulated in vitro on a medium of pH 11; however, nothing was known of its potential to suppress *R. solani*.

A sugarbeet damping-off test was used to compare the biocontrol potential of alkaline-tolerant isolate (TpH) with a known biocontrol isolate (TPW) of *T. harzianum*. Pasteurized soil at pH 6.7 was used for the first test, and soil adjusted to pH 8.2 with hydrated lime was used for the second test. Soil was infested with a low concentration of inoculum of *R. solani*. *Trichoderma* isolates were added to soil at a concentration of 10^6 colony-forming units per gram soil. Twenty-five sugarbeet surface-disinfested seeds were planted in each pot; pots were irrigated immediately and, thereafter, as needed. After 14 days, % damping-off was recorded, seedlings were harvested, and the pots were replanted. There were six successive plantings in test 1 and three in test 2.

At a soil pH of 6.7, both isolates of *Trichoderma* significantly suppressed damping-off in the first and second plantings, as compared with the control in which only the pathogen (RS) was present (Fig. 1). The wild-type of *Trichoderma* (THW) showed significantly better biocontrol than the alkaline-tolerant isolate (TpH). By the sixth planting, there were no significant treatment differences.

At soil pH 8.2, there were no significant treatment differences at planting 1, although both *Trichoderma* isolates tended to reduce damping-off (Fig. 2). At plantings 2 and 3, both isolates significantly reduced damping-off, with no difference between the isolates. Test 2 was terminated after three plantings because soil pH had returned to the original 6.7 of greenhouse potting soil.

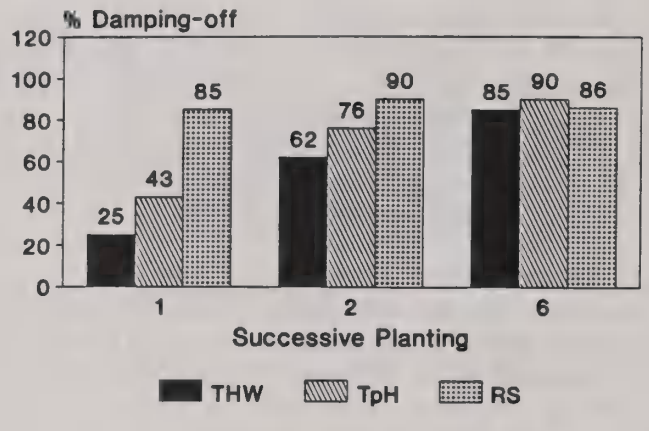


Fig. 1. Percent damping-off of sugarbeet seedlings as affected by a wild-type isolate (THW) and an alkaline-tolerant selection (TpH) of *Trichoderma harzianum* in soil of pH 6.7 infested with *Rhizoctonia solani* (RS). Six successive plantings were made at 14-day intervals; results of plantings 1, 2, and 6 are presented.

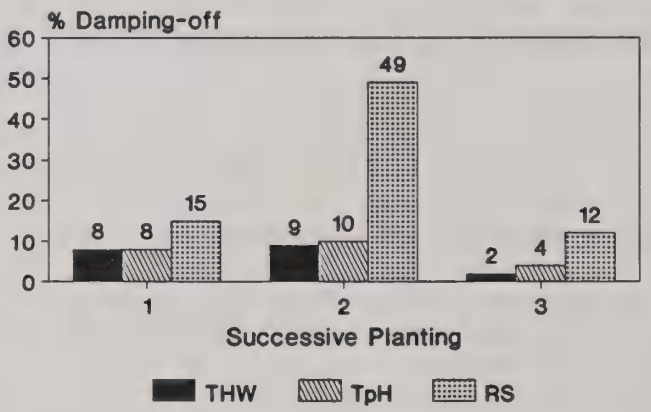


Fig 2. Percent damping-off of sugarbeet seedlings as affected by a wild-type isolate (THW) and an alkaline-tolerant selection (TpH) of *Trichoderma harzianum* in soil of pH 8.2 infested with *Rhizoctonia solani* (RS). Three successive plantings were made at 14-day intervals.

The alkaline-tolerant isolate (TpH) was not as effective as the wild-type isolate in suppressing damping-off at soil pH 6.7, and was no more effective at soil pH 8.2. Biocontrol potential, therefore, does not seem to be associated with alkaline tolerance. The reduced amount of damping-off by *R. solani* at soil pH 8.2 was surprising, because the pathogen is reported to be highly virulent in a wide range of soil reactions. Tests will be conducted to compare survival and longevity of the alkaline-tolerant and wild-type isolates of *T. harzianum* in alkaline soil. Although the alkaline-tolerant isolate is somewhat less efficient as a biocontrol agent of *R. solani* than the wild type, establishment of TpH at high population densities may be possible alkaline soils.

LEAF SPOT EVALUATIONS OF SUGARBEET LINES SUBMITTED BY BSDF-MEMBER COMPANIES (BSDF Project 255)

E. G. Ruppel and G. A. Smith

Separate randomized complete block designs with two replicates were used to evaluate a total of 139 lines submitted by six BSDF-member companies for resistance to *Cercospora beticola*. Internal controls were a highly susceptible synthetic and a resistant check, FC(504 x 502/2) x SP6322-0. Two-row plots were 4 m long with 56 cm between rows. We inoculated twice (June 23 and June 30), and evaluations were made on August 9 and 16.

The 1988 leaf spot epiphytotic developed rapidly, and disease intensity appeared to be greater than we have experienced in the past 20 years when a severe hail storm on August 3 caused significant damage to the plants in the nursery. Tattered, infected leaves made evaluations difficult; however, we feel that we still were able to differentiate among lines having varied degrees of resistance. On our disease scale of 0 to 10, the resistant and susceptible checks had mean disease indexes of 4.1 and 6.5, respectively; in 1987, these means were 3.1 and 6.1, respectively. Means of contributed lines on August 16 ranged from 3.0 to 8.0, compared with 2.5 to 8.0 in 1987. Means of the individual tests were tabulated, statistically analyzed, and sent to the appropriate contributor.

IN VITRO TECHNOLOGY AND USE OF POLLEN TO ASSAY AND SELECT FOR ECONOMIC CHARACTERS (BSDF Project 760)

R. J. Hecker

The purpose of this project is to test in vitro techniques with pollen or other tissue to assay plants or populations for genotype or genetic worth, and to make genetic selection. At this time, our experiments are primarily tests of the hypothesis that genetic characteristics of the sporophyte can be identified in the gametophyte (pollen). However, the traits we are testing are of practical importance. Since pollen is haploid and millions of genotypes can be tested in a few petri dishes, this tissue has potential to be manipulated like microorganisms. Also, pollen has many advantages over callus or suspension culture for many purposes. However, pollen is not regenerable and can only be used to fertilize plants that have not been subjected to the same challenge or selection as the pollen. This is not a serious problem because, after the one rare genotype has survived some challenge and has fertilized an ovule while all other pollen has been killed, the resultant plant may segregate 1:1 or 1:3, not 1:1,000,000, and conventional plant selection and breeding can be used.

Subsequent sections report results for several pollen challenge experiments and other experiments related to use of pollen as an experimental tissue.

Challenge and Selection of Pollen for Faster Germination and Seedling Growth at Low Soil Temperature. Two experimental approaches have been used to challenge pollen by low temperature to test the hypothesis that ability of pollen to function or survive at low temperature will result in seedlings that germinate, emerge, and develop more rapidly in cold soil.

The first method challenged pollen to effect fertilization at 8 C. We have executed four cycles of challenge in a broad based population by placing about 20 flowering male-sterile (aa) segregants in a growth chamber at 8 C, then we collected pollen from pollen-fertile (AA and Aa) sib plants in the greenhouse and blew this pollen onto the female plants in the 8 C chamber. This was repeated for 5 days, then the male-sterile plants were left in the 8 C environment 3 more days; finally they were removed to a normal-temperature greenhouse isolation. Fertilization and seed set on the 20 plants was relatively successful, about 4 g of seed was produced per plant in each cycle. We also determined that 5 days after the first 8 C fertilization there was pollen germination on the stigmas and, presumably, fertilization. This was determined by sacrificing some stigmas, staining with aniline blue, and observing with the microscope.

After four cycles of challenge and a seed increase of the 4th cycle, we tested the resultant population for ability to function and develop more rapidly at low temperature. Five types of tests were used: (1) speed of emergence through 2.5 cm of soil at 10 C, Table 1; (2) root elongation at 12 C; (3) pollen germination and tube length at 8 and 12 C, Table 2; (4) dry matter accumulation in the growth chamber at 15/10 C, Table 3; and (5) emergence in the field at Ft. Collins (planted 4-14-88), Table 4.

When seeds were planted 2.5 cm deep in flats of soil and held at 10 C in a growth chamber, the 4th cycle population emerged slightly but significantly more rapidly than its source population (Table 1). On day 15 after planting, the 4th cycle had a 9% emergence advantage. Emergence in a 24 C chamber was not different at any time (data not shown).

Table 1. Speed of seedling emergence (cumulative %) through 2.5 cm of soil at 10 C in a growth chamber from seed of the 4th cycle of low temperature challenge of pollen and its source population.

Days post-planting	4th cycle population (%)	Source population (%)	Difference
14	9	4	5
15	22	13	9*
16	38	35	3
17	50	50	0
20	72	79	-7
23	90	93	-3
27	95	99	-4
31	98	100	-2
39	100	100	0

*Significant (5%) difference between accumulated % germination of the two populations.

When pollen from the 4th cycle population and the source was germinated in vitro, germination and tube lengths were compared at 8, 12, and 24 C (Table 2). Pollen from the 4th cycle did not appear to germinate more rapidly or more completely at 8 and 12 C than the source. However, the 4th cycle pollen produced longer pollen tubes at 8 and 12 C after 24 hours than did source pollen, indicating a form of low temperature advantage of the 4th cycle population.

Table 2. Pollen germination in vitro and tube length of the 4th cycle population from low temperature pollen challenge and its source population.

Temperature & Character	6 hrs		24 hrs		48 hrs	
	4th Cy.	Source	4th Cy.	Source	4th Cy.	Source
Germination (%)						
Exp. 1						
8 C	-	-	1.2	1.1	1.9	1.4
12 C	-	-	3.3	2.1	-	-
24 C	-	-	24.7	26.3	-	-
Exp. 2						
8 C	0.1	0	0.2	0.5	0.6	1.2
12 C	0.7	0.3	2.1	4.1	-	-
24 C	8.2	19.2	25.4	45.4	-	-
Tube length (μm)						
Exp. 1						
8 C	-	-	193	154	337	217
12 C	-	-	617	421	-	-
24 C	-	-	852	975	-	-
Exp. 2						
8 C	67	0	82	60	82	93
12 C	78	73	100	61	-	-
24 C	362	328	584	612	-	-

When seed of 4th cycle and source were grown to the 4-leaf stage in growth chambers at 15 C day/10 C night and at 24/19, there was no significant advantage of the 4th cycle population at 15/10 (Table 3).

Table 3. Fresh and dry weight (g) of 4th cycle and source populations at 6-leaf stage of growth at low and ideal temperature.

Variable	15/10 C		24/19 C	
	4th Cy.	Source	4th Cy.	Source
Total wt., dry	0.26	0.26	0.17	0.18
Root wt., dry	0.07	0.08	0.03	0.04
Top wt., dry	0.19	0.18	0.14	0.14
Total wt., fresh	2.26	2.04	2.24	2.26
Root wt., fresh	0.65	0.68	0.32	0.36
Top wt., fresh	1.61	1.36	1.92	1.90

A field test of challenge cycles 1, 3, and 4 and source population was planted at Fort Collins 4-14-88. Although the 4th cycle seedlings emerged slightly more rapidly through day 15, the differences were not significant (Table 4). This test was continued and harvested 10-4-88. There were no significant differences for sucrose and root yield between the 4th cycle and source population (Table 5).

Table 4. Field emergence counts (cumulative %) of the 4th cycle and source populations, planted 4-14-89 at Fort Collins, CO.

Days post planting	Emergence (cumulative %) 4th Cycle	Source	Difference
11	26	26	0 NS
12	48	43	5 NS
13	67	64	3 NS
14	86	84	2 NS
15	97	91	6 NS
17	99	100	-1 NS
19	100	100	0 NS
22	85	92	-7 NS

Table 5. Sucrose and root yield of the 4th, 3rd, and 1st cycles and source population, as well as a check at Fort Collins, 1988.

Population	Sucrose %	Root yield kg/6m row
4th Cycle	13.6	15.9
3rd Cycle	13.9	15.4
1st Cycle	14.0	17.7
Source	14.1	17.8
Mono-hy 55	14.7	22.0
LSD (.05)	1.7	2.5

Root elongation rates of 4th cycle and source populations were not significantly different in blotter germination and growth tests at 12 and 23 C (data not shown).

Among the several comparisons of the 4th cycle and source populations, only pollen tube growth and seedling emergence in 10 C soil showed an advantage for the 4th cycle population at low temperature. Hence, there was evidence that four cycles of low temperature pollen challenge caused the sporophytic generation to germinate, emerge, and develop more rapidly at low temperature, but not as measured by all tests. Because of this inconsistency, which may have been related to technique, we are testing another technique of direct chill injury

of pollen by exposure of desiccated pollen to low temperature (2 C) during humidification. This cold shock caused pollen lethality of 40-80%, as measured by in vitro germination. The 1st cycle population from pollen challenged by this technique had improved cold tolerance in one line and unchanged tolerance in another, as measured by in vitro pollen germination and tube growth at 12 C (data not shown). These results were supported in tests of root elongation at 12 C, when these two lines were compared with their source populations. This low temperature challenge technique appears more promising than challenge during fertilization, which is being terminated with the four cycles reported here. A 2nd cycle of challenge and fertilization with challenged pollen is currently in progress.

This research has provided some evidence that challenge and selection in pollen is expressed in the succeeding sporophytic generations. For practical purposes, genotypes that germinate, emerge, and develop more rapidly in cold soils have potential to significantly boost sucrose production per unit area of land.

In Vitro Assay for Resistance of Sugarbeet to Rhizoctonia solani. This part of the project is designed to develop in vitro technology that will identify more precisely genotypes that are resistant to root rotting strains of *R. solani*. Such technology would be useful for in vitro assay and selection, allowing more genotypes to be more accurately screened at less cost than in conventional or transformation breeding programs.

The soil-borne fungus *R. solani* invades sugarbeet roots and crowns by excretion of enzymes that hydrolyze pectic and cellulosic components of cells. If these enzymes also affect sugarbeet pollen function, we reasoned that pollen from resistant and susceptible plants may be affected differently. Knowing the classes of enzymes produced by *R. solani*, we bought off-the-shelf enzymes from Sigma Co. and tested them for effect on pollen in liquid germination medium. Last year, we reported differential effects of several enzymes on pollen germination, in some cases low concentrations of enzymes enhanced germination of pollen from susceptible plants, but did not affect resistant pollen. However, germination enhancement is difficult to quantify, so we tested ion leakage from pollen incubated at 24 C for 24 hours in enzyme-amended liquid medium. K^+ was the only consistently leaked ion of 19 that were measured by ICP spectroscopy. Conductivity and flame photometry did not provide satisfactory measures of general or specific ion leakage.

The effects of enzyme treatments on pollen germination are shown in Table 6. Five of the seven enzymes, at low concentrations, produced differential effects on pollen germination, i.e., enhancement in pollen from susceptible plants, and no effect or a negative effect on pollen from resistant plants. Higher enzyme concentrations were deleterious to germination in almost all cases. The most consistent enhancement effects occurred with pectinase, pectolyase, and cellulase

The effects of enzymes on K^+ leakage are shown in Table 6. Only pectinase and pectolyase had differential effects on susceptible and resistant pollen. Both enzymes induced significantly greater K^+ leakage from resistant than susceptible pollen, as well as more leakage than the control (pollen, but no enzyme in the medium).

Table 6. Effect of enzymes on pollen germination and K^+ leakage in liquid medium (separate experiments).

Enzyme, conc. (units/ml) & control	Pollen germination (%) Susc.	Resist.	Pollen K^+ leakage (ppm) Susc.	Resist.
Pectinase				
0.02; 0.1*	46a**	23a**	10.4b***	12.9a***
Control	24b	26a	2.2c	2.8c
Pectolyase				
0.01; 0.1	42a	22a	4.6b	6.8
Control	28b	27a	1.6d	3.6c
Cellulase type I				
0.5; 1.0	61a	21b	22.3a	21.4a
Control	38b	33a	1.9b	2.4b
Cellulase type V				
0.2; 1.0	66a	25a	4.4a	4.7a
Control	34b	19a	2.5b	2.1b
Cellulase type VII				
1.0	60a	32a	-	-
Control	23b	29a	-	-
Pectinesterase				
1.0; 1.0	22a	22a	1.6a	1.7a
Control	24a	16a	0 a	0 a
Hemicellulase				
2.0	32a	30a	-	-
Control	19b	20b	-	-

* First number = enzyme concentration in germination medium. Second number = enzyme concentration in K+ leakage medium.

** Different letters within column within enzyme designate significant differences. (P = 0.05)

*** Different letters within enzyme designate significant differences. (P = 0.05)

There generally were no K^+ leakage differences between resistant and susceptible pollen in the absence of enzyme, which indicates similar electrolyte contents. Hence, the greater K^+ leakage from resistant pollen indicates that pectinase and pectolyase affect the pollen intine or tube membrane differently.

Our research with off-the-shelf enzymes is being coordinated with Dr. Bugbee's research (ARS, Fargo) with enzymes synthesized specifically by root rotting strains of *R. solani*. Our preliminary tests with his purified pectin lyase showed high potency on pollen; it was lethal at relatively low concentrations.

The results that we and Dr. Bugbee have had do not lead to a logical single theory or explanation. Our finding, that low concentrations of two pectic enzymes enhance pollen germination in susceptible pollen but have no effect on resistant pollen, indicates that the intine of susceptible pollen may be more vulnerable and allow more pollen to germinate in the in vitro environment. However, the greater K^+ leakage from resistant pollen seems to be contrary to this explanation. Also the greater K^+ leakage seems contradictory to Dr. Bugbee's evidence of an enzyme inhibitor(s) in resistant plants.

Our results indicate that we may be able to develop an in vitro quantitative measure that is directly related to rhizoctonia resistance in sugarbeet. We plan to continue this work, concentrating on ion leakage as a measure of resistance across a range of genotypes. Also, off-the-shelf enzymes of different sources will be tested. Cooperation with Dr. Bugbee will be continued.

This research is designed to provide new biotechniques for precise determination of level of genetic resistance to *Rhizoctonia* in order that breeders can rapidly and efficiently transfer resistance into parents of their best hybrids. This type of genetic identification will be necessary whether genes are brought into these parents by conventional crossing or by transformation techniques that are yet to be developed.

Long Term Pollen Storage. In July 1985, sugarbeet pollen was collected, desiccated to 9.3% moisture, divided into ten 12-mg samples, and cryopreserved in liquid nitrogen. When samples were removed, they were warmed at 24 C for 30 minutes, then humidified for 30 minutes. In vitro pollen germination in liquid medium at collection, 6 months, 1 year, 2 years, and 3 years was measured, along with pollen tube length, viability stain, seed set, and viability of seed (Table 7). After pollen germination and viability tests, the remnant pollen was blown onto flowering male sterile plants. Seed set was the percentage of open flowers at pollination that produced an apparent seed. Viable seed was the percent of those seed that germinated.

Table 7. Test means of cryopreserved sugarbeet pollen.

Time in liquid N	In vitro germ. (%)	Tube length (μm)	FDA stained (%)	Seed set (%)	Viable seed (%)
Control (24 hrs)	32	-	-	-	-
0.5 yr	29	361	-	33	21
1 yr	34	275	-	-	9
2 yr	38	547	88	3	83
3 yr	22	491	77	12	92

The pollen viability after 3 years of storage, as shown by germination (22%), may indicate a decline. Tests planned for years 4 and 5 should determine the trend. Samples remain in storage for testing in years 4, 5, 10, 15, and 20.

Pollen Challenged by Salinity in Vitro. We have developed techniques for challenging pollen in a highly saline (NaCl) medium, then cleansing, recovering, and fertilizating with the pollen. This pollen, after cleansing, germinated 4% in vitro, compared with 42% for unchallenged pollen of the same collection. The progeny resulting from fertilization with challenged pollen are currently flowering, and the pollen is being similarly challenged to produce a 2nd cycle salt-challenged population. The pollen also was tested for its ability to germinate in NaCl-amended medium. The results are shown in Table 8.

Table 8. Germination % (in vitro) of pollen from the 1st cycle salt-challenged population and its parental source.

Population	NaCl concentration of medium		
	0 M	0.08 M (8EC)	0.11 M (12EC)
1st cycle challenge	7.2	4.3	0
Source	13.0	0.1	0

The evidence of improved salinity tolerance in the first cycle population is weak. The succeeding second cycle seed will be tested for sporophytic tolerance.

SUGARBEET RESEARCH

1988 Report

SECTION D

Northern Crop Science Laboratory, Agricultural Research Service,
U.S. Department of Agriculture, Fargo, North Dakota

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Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
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Sugarbeet Research and Extension Board of
Minnesota and North Dakota

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CONTENTS

NEW FACILITIES AND STAFF FOR SUGARBEET RESEARCH AT FARGO, NORTH DAKOTA

G. A. SMITH

Occupancy of the new ARS Northern Crops Science Laboratory on the North Dakota State University campus was begun in May 1988 and completed in July 1988. The Northern Crop Science Laboratory (NCSL) is a facility of the Agricultural Research Service of the U.S. Department of Agriculture completed in March 1988 at a cost of $8.3 million. The 71,000 square-foot building is located in the southwest corner of the North Dakota State University campus in Fargo, ND. Fifteen Federal scientists and five State cooperator scientists conduct research to expand and retain profitable production of barley, hard spring wheat, durum wheat, sunflowers, and sugarbeets. One wing of the laboratory houses the University Electron Microscopy Facility.

The Laboratory scientists were previously located in various buildings on the University campus, but now have been drawn together into an environment that nurtures a strong, team-oriented approach to problem solving. One scientist (Research Geneticist) and the partial services of two other scientists (Cytogeneticist and Botanist) were transferred to the sugarbeet staff by the end of December 1988. The research scientists currently on the staff include two geneticists, one agronomist, one pathologist, and the partial services of one cytogeneticist and one botanist. In addition, a support scientist with molecular biology training was hired in March 1989.

The design and site of the Northern Crop Science Laboratory were specifically selected to facilitate efficient research by the scientists. The laboratories adjoin a group of pre-existing greenhouses which permits efficient transfer of plant material to individual laboratories within the complex, particularly during winter months when exposure of plant material to the outdoor environment would be damaging. Two greenhouse ranges and a headhouse (10,400 sq. ft.) were added to this complex as part of the construction project. The laboratory is also situated adjacent to the experimental field plots. Plant material from the plots can be delivered to a special seed cleaning, drying, and storage area of the laboratory complex, which is physically and mechanically isolated from sensitive laboratory areas that require a high degree of cleanliness.

The two laboratory wings of the research complex feature several support spaces immediately adjacent or in close proximity to each main laboratory. These include scientists' offices, conference rooms, instrument rooms, sterilizing and dishwashing rooms, tissue culture rooms, darkrooms, and storage rooms. All working areas of the laboratory complex are handicap-accessible. There is also an employee room, several small conference rooms, and one large conference room.

In addition to the building proper, approximately $500,000 of new equipment and furniture was purchased to equip the laboratories. Included were such items as ultracentrifuges, GC-mass spectrometer, lyophilizer, liquid scintillation counter, HPLC, transfer hoods, refrigerators, and freezers.

Special design consideration was given to safety and operating efficiencies within the laboratory. Emergency power outlets are distributed throughout the laboratories and are coupled to a 600 KVA diesel generator to supply power for critical equipment. Every laboratory and office is provided with computer and

telephone outlets. Special filtering systems provide triple filtered air to the laboratories, the final one being a 1-micron filter to reduce contamination of cultures. Each laboratory is equipped with a fire extinguisher, fire blanket, eye wash station, and emergency shower. Performance of the heating and ventilating system is monitored by a Honeywell DeltaNet computer system. Building security is enhanced by use of non-magnetic cards for building access instead of keys.

Electron Microscope Facility.--The University Electron Microscope Facility provides equipment, technical assistance and support to North Dakota State University teaching and research scientists as well as to USDA scientists. Typically, over 100 scientists representing 29 departments make use of the facility each year. The areas of research interest are primarily biology and related to the needs and interests of the agricultural community.

The laboratory (3,500 sq. ft.) was designed specifically to meet the requirement of ultrastructural research. A central preparation area provides space for each phase of sample preparation. Although this area is in the center of the building, the architectural design provides for natural lighting in the work area. The central bench features a unique exhaust system for critical point dryers, sputter coaters and vacuum evaporator. Three stainless steel fume hoods with flammable storage bases and a vented chemical cabinet are situated at one end of the central preparation area. Microscope rooms, darkrooms, ultramicrotomy room, light microscopy room, research specialist and scientist offices and a conference room surround the central preparation area. Each of the four electron microscope rooms features a vibration isolation pad, access to centrally plumbed chilled water and nitrogen gas. The exhaust from all vacuum pumps is vented directly to the building exterior. The ultramicrotome room utilizes baseboard heat to minimize air currents at the level of the instrument. The design of the laboratory allows the research specialist to supervise laboratory activity from his desk. Due to the nature of the chemicals used in the preparation of biological samples for electron microscopy, the entire laboratory is under a slight negative pressure as a safety precaution.

Special Support Areas.--A distinctive feature of the laboratory complex is a growth chamber facility. Within this room are 19 chambers, valued at a quarter-million dollars, in which biological materials may be exposed to a time-controlled environment of temperature, light, and relative humidity. The chambers range in size from 17 cubic feet (refrigerator size) to 587 cubic feet walk-in rooms. All the chambers are produced by a single manufacturer, Percival, and can be programmed and monitored from a centralized computer. Alternatively, the environments can be manipulated by a control panel on each chamber. The selection of a single manufacturer simplified the servicing requirements of the facility.

Research at this facility involves both sophisticated laboratory experiments, in which conditions must be extremely clean and dust-free, and field and greenhouse experiments, in which soil and organic dusts are unavoidable. These two types of research are isolated from each other in separate building areas connected by corridors. Materials from experimental field plots or greenhouses are received into the building and processed without affecting experiments in the main laboratories.

Plant materials from the field or greenhouse can be dried, if necessary, by placing them in drying chambers in which heated, forced air is moved through the materials. Rooms for storage of these materials for later processing are available. Nearby rooms for threshing, seed cleaning or other processing have elaborate systems for removing plant dust and chaff and for maintaining room air with a minimal amount of dust. All electrically-powered threshing and cleaning equipment have explosion-proof electrical connections to provide a safe operating environment.

A large cold storage room is used for long-term viability maintenance of crop seeds by controlling temperature and humidity. Valuable germplasm can be preserved for many years. The USDA World Collection of Flax, a working collection, is among the materials stored in this facility.

Transfer rooms contain isolation or transfer hoods which are used to assure sterile conditions. A second type of hood is located in certain transfer rooms which allows the transfer of bacterial or fungal cultures without contamination of other cultures within the transfer room.

Tissue culture rooms were designed with complete temperature and humidity control along with triple-filtered air to provide the stringent environment necessary for establishing and maintaining cells and tissues developing from these cells. Mobile racks were constructed with individually controlled light banks over each shelf for maximum flexibility of growth conditions.

Vernalization rooms were designed to provide the temperature and light conditions necessary to induce the flowering response in sugarbeet and the heading response in winter wheats. Temperatures in these rooms are maintained at 40 degrees with constant fluorescent light for 4 to 6 months to induce flowering in sugarbeet. A temperature of 38 degrees is maintained for 30-40 days with 14 hour/day fluorescent light to induce the heading response in young wheat seedlings.

Sugarbeet Research at the Northern Crop Science Laboratory.--Sugarbeet research at the laboratory includes the following:

1. Identifying biochemical mechanisms of resistance against *Rhizoctonia solani* with specific interest in the pectin lyase enzyme produced by the fungus and with the inhibitor produced by resistant plants.

2. Germplasm development for Cercospora resistance and other genetic attributes and evaluation of new (exotic) germplasm.

3. Development of new technologies for producing transgenic bacteria for use as a biopesticide--interest here being driven by the impending loss of currently-used systemic insecticides due to threat of groundwater contamination.

4. High sucrose research.

5. Storage loss research.

PUBLICATIONS

Abstracts of Papers Published or Approved for Publication and Germplasm Registrations

Campbell, L. G. 1989. *Beta vulgaris* NC-7 collection as a source of high sucrose germplasm. *J. Sugar Beet Res.* 26:1-9.

Among the major problems facing sugarbeet breeders are lack of genetic diversity and the negative association between root yield and sucrose concentration. The USDA-ARS *Beta* collection contains a wide array of material that has not been utilized fully. In this study 167 accessions of the NC-7 collection were evaluated for sucrose concentration on an individual root basis. A breeding population was formed by interpollinating 30 individuals with relatively high sucrose concentration. Seed from each plant were harvested separately and progeny were evaluated the following year in replicated field plots. Subsequent selection was based upon both individual and family performance. Selected plants were interpollinated, seed were harvested again from individual plants and the progenies were evaluated as a family. This procedure was repeated in each of five selection cycles. After the second cycle it was apparent that root weight was decreasing drastically, so individual root weight was added to the selection criteria. The average sucrose concentration of fifth-cycle families was increased to 113% of Ultramono. Five families combined high sucrose concentration with average root yield in the fourth and fifth selection cycles. This research indicates that germplasm collections of the USDA can be used for improving yield and quality of sugarbeet and for widening the genetic base of the sugarbeet crop.

Campbell, L. G. Registration of F1010 sugarbeet germplasm. (Approved by ARS for publication in *Crop Science*)

F1010 sugarbeet germplasm was developed by the USDA-ARS and the North Dakota Agricultural Experiment Station. F1010 is a population with relatively high sucrose concentration selected from the USDA-ARS *Beta* germplasm collection (NC-7) maintained at Ames, Iowa. F1010 resulted from five cycles of selection based upon both family and individual root sucrose concentration. The average weight of selected beets was approximately equal to the weight of the hybrid checks, thus preventing the drastic decline often associated with selecting solely for sucrose concentration. This germplasm makes readily available a portion of the genetic diversity within the USDA NC-7 collection. F1010 is intended to provide a unique genetic source for the development of populations and parental lines with improved agronomic performance.

Campbell, L. G. and W. M. Bugbee. Registration of sugarbeet germplasm with combined storage-rot resistance and low storage-respiration rate. *Crop Sci.* 29: in press.

F1009 sugarbeet germplasm was developed by the USDA-ARS and the North Dakota Agricultural Experiment Station. It possesses resistance to three major storage-rot fungi and has a postharvest storage-respiration rate substantially below current commercial hybrids. Selection for low respiration rate was accomplished by measuring internal CO_2 levels of individual sugarbeet roots during storage. Selection for storage-rot resistance was accomplished by rating individual roots for their response to *Phoma betae* (Oud.) Frank, *Penicillium claviforme* Bainier, and *Botrytis cinerea* Pers ex Fr. F1009 resulted from six cycles of selection within a population formed by randomly interpollinating 19 genetically diverse individuals previously selected for either low storage-respiration or storage-rot resistance. F1009 is intended to provide a genetic source for the development of populations and parental lines with improved storability characteristics.

Doney, D. L. 1988. Selection for sucrose yield in stressed sugarbeet seedlings. *Crop Sci.* 28:245-247.

Progress in improving sucrose yield in sugarbeet (*Beta vulgaris* L.) has been slow, due to large environmental variation associated with root yield and a negative correlation between root yield and sucrose concentration. Appropriate stress applied on segregating populations could increase performance differences among genotypes and increase the genetic variance. Stress that forces defoliated plants to grow new leaves from their stored root reserves logically ought to select for increased photosynthate storage and, therefore, increased sucrose yield. Stress was imposed in greenhouse tests by trimming the leaves from 3- to 4-week-old sugarbeet seedlings and covering them with black plastic, thereby forcing the plants to grow new leaves from their stored root reserves. When this stress was imposed on seedlings of a series of cultivars varying in root yield and sucrose potential, those cultivars with the highest potential sucrose yield had the greatest survival rate (fewest plants dying). The correlations between percent survival after stress and total sucrose yield were 0.96 and 0.90 for field and greenhouse replicated trials, respectively. Open-pollinated seed increases of the surviving plants in two heterogeneous populations resulted in increases in field root yield, sucrose concentration, and total sucrose yield. These increases, although in a favorable direction, were not always at the desired probability of significance. Data combined over two years of testing gave significant increases in total sucrose yield for the two new stress selection populations over their parents at the 0.07 and 0.14 probability levels. This method shows promise as a quick, inexpensive technique for improving both root yield and sucrose concentration.

Doney, D. L. and E. D. Whitney. Germplasm collection and preservation: Insurance for the future. (Approved by ARS for publication in *Journal of Economic Botany*)

Although agronomically undesirable and offering little commercial value, wild relatives of our present crop plants may have many desirable stress-resistant characteristics due to long exposure to nature's stresses. Early U.S. collection activities for wild forms of *Beta* were conducted by George H. Coons (USDA-ARS) in 1925 and 1935. These collections were mainly wild forms of the Section Beta, with major emphasis on leaf spot (*Cercospora beticola*) resistance. Resistance in wild sugarbeet hybrids was not notably improved over the sugarbeet parents and the evaluation was discontinued. Nothing more was done with this collection until 1976, when John McFarlane (USDA-ARS) transferred it to Salinas to regenerate seed for preservation. Unfortunately, about half of the collection had lost germinability. Rhizomania, a devastating sugarbeet root disease, was discovered in California in 1983. Shortly after this discovery, E. D. Whitney began screening some of the Coon's collection for Rhizomania resistance and found immunity in several accessions. Interestingly, these same accessions subsequently have been found to exhibit Erwinia root rot resistance, sugarbeet root maggot tolerance, and moderate leaf spot resistance. Needs change and the value of wild germplasm may not be realized for years. The need to collect and preserve this valuable natural resource is illustrated by these examples of pest resistance. As future needs for other traits develop, the true value of these collections will be realized.

Henningson, P. J., B. A. Vick, W. M. Bugbee, and N. C. Gudmestad. 1988. Characterization of 12-methyl-*cis*-4-tetradecenoic acid from *Corynebacterium sepedonicum*. *Lipids* 23:1086-1088.

A previously uncharacterized fatty acid found in *Corynebacterium sepedonicum* was analyzed by gas chromatography-mass spectrometry and infrared spectrometry and determined to be 12-methyl-*cis*-4-tetradecenoic acid. This fatty acid represents nearly 6% of the total fatty acids of *C. sepedonicum*, but it is present at significantly lower levels in other *Corynebacterium* species. Therefore, 12-methyl-*cis*-4-tetradecenoic acid provides a useful marker in distinguishing *C. sepedonicum* from other microorganisms.

Smith, G. A. 1988. Effects of plant breeding on sugarbeet composition. Chapter 2 *in* M. A. Clarke and M. A. Godshall (eds.), Chemistry and Processing of Sugarbeet and Sugarcane. pp. 9-17. Elsevier, Amsterdam.

Soluble nonsucrose constituents in extracted sugarbeet juice are a major concern to sugar processors because they impede crystallization and thus lower extraction of sucrose. Selection response for nonsucrose root extract chemical constituents known to affect sucrose recovery in sugarbeet (*Beta vulgaris* L.) was determined in a heterogeneous population. The objectives of the research were to determine the direct effects of cyclic selection for specific root

extract chemicals and the indirect effects of this selection on other purity-determining chemicals. Two cycles of selection for high and low Na^+, K^+ and amino N were used to develop populations which were then compared to their common parental population in 3 years of field testing. Significant population mean shifts for extract chemical composition occurred in the newly synthesized populations developed by high or low selection. Selection for reduced Na^+ (one of the three chemical constituents previously identified as important to juice quality) significantly increased purity and extractable sucrose. The effect of selection on other non-sucrose chemicals was often dramatic and not predictable, although a strong positive association was detected between Na^+ and Cl^-.

Papers Published Since Abstracted in Previous Report

Bugbee, W. M. 1988. Purification of pectin lyase from cultures of *Rhizoctonia solani* AG 2-2 and extracts of infected sugar beet roots. *Phytopathology* 78: 1590. (Abstract)

Bugbee, W. M. and L. G. Campbell. 1989. Dual resistance in sugarbeet to *Rhizoctonia solani* and *Phoma betae*. *J. Sugar Beet Res.* 26:A4. (Abstract)

Bugbee, W. M. and N. C. Gudmestad. 1988. Recovery of *Corynebacterium sepedonicum* from sugar beet seed. *Phytopathology* 78:205-208.

Campbell, L. G. and W. M. Bugbee. 1988. Selection for improved storability. *Crop Sci.* 28:33-36.

Campbell, L. G. and W. M. Bugbee. 1989. Inheritance of storage-rot resistance. *J. Sugar Beet Res.* 26:A4. (Abstract)

Campbell, L. G. and D. F. Cole. 1988. Registration of two sugarbeet germplasms having low storage-respiration rates. *Crop Sci.* 28:205-206.

Doney, D. L. and E. D. Whitney. Germplasm collection, preservation, and evaluation: A sugarbeet experience. Proc. Beltsville Symposium XIII: Biotic Diversity and Germplasm Preservation - Global Imperatives, May 7-9, 1988. Section II: pp. 5. (Abstract)

Doney, D. L. and E. D. Whitney. 1989. *Beta maritima* (sea beet) germplasm in England, Wales and Ireland. *J. Sugar Beet Res.* 26: A6. (Abstract)

Gudmestad, N. C., P. Henningson, and W. M. Bugbee. 1988. Cellular fatty acid comparison of strains of *Corynebacterium sepedonicum michiganense* f. sp. *sepedonicum* from potato and sugar beet. *Can. J. Microbiol.* 34:716-722.

Smith, G. A. 1987. Sugarbeet. Chapter 15 *in* W. R. Fehr (ed.), Principles of Cultivar Development. Vol. II, Crop Species. pp. 577-625. MacMillan, New York.

Smith, G. A. 1987. Sugar Crops. Chapter 7 *in* B. R. Christie, ed. CRC Handbook of Plant Science in Agriculture. Vol. II. pp. 125-135. CRC Press, Boca Raton, Florida.

Smith, G. A. 1989. Research at the new Northern Crop Science Laboratory. *J. Sugar Beet Res.* 26: A23. (Abstract)

Smith, G. A. and S. S. Martin. 1989. Effects of selection for sugarbeet purity components on quality and sucrose extraction. *Crop Sci.* 29: in press.

Smith, G. A. and E. G. Ruppel. 1988. Registration of FC 609 CMS sugarbeet germplasm. *Crop Sci.* 28:1039.

CERCOSPORA RESISTANCE BREEDING AND RELATED RESEARCH (BSDF PROJECT 250)

G. A. SMITH and E. G. RUPPEL

1988 Cercospora Field Research.--The 1988 Cercospora field research supported by BSDF Project 250 was conducted for the seventh year on Colorado State University land located west of the CSU Veterinary Research and Teaching Center. The Cercospora nursery was planted April 14. The nursery was inoculated on June 23 and on June 30. The first of two disease evaluations was conducted on August 9 and the final evaluation on August 16. On August 16, the mean leaf spot rating of the resistant and susceptible checks were 4.0 and 7.0, respectively. These values compare with 2.8 and 6.1 for resistant and susceptible checks, respectively, in 1987. Twenty-four of the 58 entries, or 41%, equaled or exceeded the resistant check for leaf spot resistance (Table 6).

Table 1. Mean leaf spot ratings of breeding lines at Fort Collins, Colorado, 1988. (BSDF Project 250)

Entry No.	Seed No.	Description/Pedigree	Leaf Spot Rating[a]
1661	861011H2	FC 606 T.O., rr, mm X (FC 701/4, 94% R-MM X FC 606 T.O., rr, mm, BC3)	5.00
1662	861012H2	(FC 607 T.O., rr, mm X FC 701/4 97% R-MM) X FC 607 T.O., rr, mm, BC3	4.00
1663	861016H0	FC 607 (4x) T.O. (C3)	4.00
1664	861016H01	FC 607 (4x) (C3)	3.75
1665	861017H0	FC 606 (4x) T.O. (C3)	5.50
1666	861017H01	FC 606 (4x) CMS (C3)	5.00
1667	861018H04	FC 607 CMS X FC 502/3 T.O.	3.75
1668	861019H02	FC 506 CMS X FC 607 T.O.	3.75
1669	861019H03	FC 502/3 CMS X FC 607 T.O.	3.50
1670	861019H04	761036H01 CMS X FC 607 T.O.	3.50
1671	861019H05	662119H01 X FC 607 T.O.	4.00
1672	861020H02	FC 607 CMS X 662119H0	4.25
1673	861020H03	FC 603 CMS X 662119H0	2.75
1674	861022H02	FC 605 CMS, mm X FC 502/2 T.O., mm	4.25
1675	861022H03	FC 504 CMS, mm X FC 502/2, T.O., mm	4.00
1676	861024H02	662119H01 X FC 605 T.O.	5.50
1677	861024H03	652016 CMS X FC 605 T.O.	5.00
1678	861025H04	FC 607 CMS X 642010 T.O.	4.50
1679	861026H03	761036H01 CMS X FC 603 T.O.	4.50
1680	861026H04	652016 CMS X FC 603 T.O.	4.00
1681	861036H0	(syn FC 701 X LSR-CTR)aa X C718; T.O., mm	4.75
1682	861036H01	C718 CMS X (syn FC 701 X LSR-CTR)	4.50
1683	861039	FC 712	5.75
1684	871016	FC 709	3.75
1685	871028H02	FC 605 CMS X FC 502/3 T.O.	4.50
1686	871028H03	FC 607 CMS X FC 502/3 T.O.	3.75

Table 1. Continued.

Entry No.	Seed No.	Description/Pedigree	Leaf Spot Rating[a]
1687	871032H02	FC 605 CMS X FC 506 T.O.	3.50
1688	871032H03	FC 607 CMS X FC 506 T.O.	4.25
1689	871033H03	761036H01 CMS X FC 605 T.O.	4.50
1690	871033H04	652016 CMS X FC 605 T.O.	3.50
1691	871034H02	FC 502 CMS X FC 607 T.O.	4.00
1692	871034H05	761036H01 CMS X FC 607 T.O.	3.75
1693	871034H06	652016 CMS X FC 607 T.O.	4.25
1694	871034H07	662119H01 CMS X FC 607 T.O.	4.00
1695	871034H09	FC 502 CMS X FC 607 T.O.	4.00
1696	871035H02	662119H01 CMS X FC 606 T.O.	4.75
1697	871035H04	FC 506 CMS X FC 606 T.O.	4.50
1698	871038H0	FC 609 T.O.	4.00
1699	871038H01	FC 609 CMS	4.50
1700	871013	Rh T.O. from (FC 607 X LSR-CTR)	3.25
1701	701212H0	$662119s_1$	4.50
1702	831125H0	FC 603 CMS X $662119s_1$	5.00
1703	781065H03	$662119s_1$ CMS X 562	6.50
1704	871039H0	syn fr [(FC 701 X mm O-T)aa X; mm O-T LSR-CTR]	5.25
1705	871043H0	2d cy Rh from (FC 607 X FC 708); mm, LSR	5.75
1706	871043H01	2d cy Rh fr (FC 607 CMS X FC 708); mm, LSR	4.00
1707	871046H0	3d cy Rh fr (± FC 609 X FC 708)	4.00
1708	871046H01	3d cy Rh fr (± FC 609 CMS X FC 708)	4.00
1709	871016	FC 709	4.50
1710	851052H04	FC 607 CMS X SP 6323-0	4.50
1711	851053H02	SP 6323-01 CMS X FC 609 T.O., mm	4.50
1712	851057H03	(622112 CMS X $622119s_1$ T.O.) X 721055 T.O.	5.00
1713	851057H02	[(FC 504 X 502/2) X 662119] X 721055 T.O.	4.75
1714	851057H04	FC 607 CMS X 721055 T.O.	5.25
1715	851052H02	(622112 CMS X $622119s_1$ T.O.) X SP 6323-01 T.O.	5.25
1716	821051H2	LSR CHECK	4.00
1717	851060	LSS CHECK	7.00
1718	821052	Yellow Leaf Mutant	6.75

[a]Leaf spot ratings based on 0 to 10 scale, with 0 = no symptoms and 10 = complete defoliation. Ratings presented were taken at the peak of the epidemic, August 16, 1988. LSD (P = 0.05) = 1.1.

IN VITRO SELECTION AND REGENERATION RESEARCH (BSDF PROJECT 750)

G. A. SMITH

The approach we have chosen for the isolation of elite genotypes, i.e., isolation of a Cercospora-resistant genotype, depends on: 1) an ability to regenerate shoots from ovule-derived callus, 2) confirmation of the ploidy level of the

regenerated plant, and 3) the initiation of new regenerable callus and cell suspensions for selection at the cellular level. Our recent trials with initiation of callus from petiole segments of regenerated haploid shoots yielded a low frequency of initiation and development using a 1.0 mg L^{-1} BAP concentration at 27 C. It appeared that thiadiazuron (an alternate cytokinin) was slightly more effective in the induction of callus. However, many adventitious shoots also developed in the presence of both cytokinins, obscuring results. Other workers, including Saunders and Shin, have reported good success initiating callus from leaf blade segments using BAP as the cytokinin.

The objective of the following reported research was to determine whether thiadiazuron is more effective than BAP in the initiation of callus from regenerated plant material. Both of these cytokinins were tested for frequency of callus initiation on leaf blade segments and on petiole sections.

Methods.--Briefly stated, methods were as follows: Segments of leaf blades (.5 cm^2) and .5 cm long petiole segments from three ovule-regenerated shoot lines were cultured on MS plus vitamins with either BAP (1.0 mg L^{-1}) or thiadiazuron (1.25 mg L^{-1}) added. Cultures were initiated and maintained in the dark at 31 C. Data including calli per plate and number of calli greater than 1 cm in diameter were recorded after six, eight, and 10 weeks.

Callus Culture Maintenance.--Organogenic callus cultures from unfertilized ovules of FC 607 and R and G Pioneer have continued to be maintained in the light in our laboratory. The regenerative capacity of four OV lines has continued for one year on media containing B5 salts, MS, minimal vitamins, and 1.25 mg L^{-1} thiadiazuron. The callus grows rapidly and must be transferred about every three weeks or the culture turns dark brown. A shift in the ratio of callus to shoot growth has been observed in three lines over the last six months, and there is now less callus and more regenerating shoots. New callus cultures have been started from petiole sections of the regenerated shoots. These cultures will be used for refining published methods for cell suspension initiation, growth, and regeneration to use for Cercospora resistance screening at the cellular level.

SELECTION FOR SUGARBEET ROOT MAGGOT RESISTANCE (BSDF PROJECT 930)

L. G. CAMPBELL

Selection for sugarbeet root maggot (SBRM) resistance was continued for a fifth year. All materials were evaluated at a site that has a history of relatively high maggot populations near St. Thomas, North Dakota. Even though SBRM populations were somewhat lower than 1987 levels, considerable SBRM damage was observed. In insecticide trials next to the nursery (conducted by A. W. Anderson, NDSU), untreated plots had an average damage rating of 3.6 (0 = no damage to 5 = severely damaged) and up to a 6.3 ton/acre yield increase resulting from insecticide treatments. We continued to select plants with low damage ratings from previously selected populations. As in the past, we observed minor differences between selected and nonselected material. The levels of resistance available would not allow for production in the absence of insecticides. The usefulness of the SBRM selections will be ascertained over the next few years while we develop new approaches to controlling this pest. We will begin a

program involving the transfer of bacterial genes toxic to the root maggot to endophytic nonpathogenic bacteria that colonize the sugarbeet.

PHYSIOLOGICAL SELECTION (BSDF PROJECT 970)

DEVON L. DONEY

Stress Selection.--Selection for genetically superior individual roots is difficult and often results in little progress. Identification of superior roots is often confounded with environmental effects, resulting in little or no genetic differences. We have found that severe stress can amplify true genetic differences. If the stress is appropriately applied, desirable genetic differences can be identified.

One such stress criterion has been effective in identifying superior genotypes for sucrose yield. In pilot tests, this selection approach was effective in improving both root yield and sucrose concentration.

The selection procedure is very simple. Plants are grown under controlled conditions to the 4-6 true-leaf stage. At that time all leaves are trimmed except the center bud. Growth is continued for 10-14 days under dark conditions to prevent photosynthesis. Those plants that have stored little sucrose die. Surviving plants are saved and intercrossed to produce the new selection population. Usually about 75% of the plants die.

We have initiated a more thorough investigation of this approach with the objective of evaluating its potential as a new rapid selection procedure. Three cycles of selection will be conducted in three diverse populations. Each of the selection populations will be crossed to a common parent and tested in replicated field trials to evaluate potential *per se* and combining ability improvement.

Green Leaf Duration.--Physiological and genetic relationships have been found in cereals between grain fill (grain yield) and green leaf duration of the flag leaf. The longer the source of photosynthate supply is active the longer the grain fill and larger the yield.

The author has observed differences in senescence (green leaf duration) among sugarbeet genotypes. If the same principle of green leaf duration exists in sugarbeet as does in cereals, then the longer green leaves remain photosynthetically active the more photosynthate is supplied to the root. This hypothesis has not been tested in sugarbeets.

In earlier studies, it was found that a relationship existed between root yield and the life span (days from planting to death) of the first true leaves. The study reported herein was designed to evaluate the relationship between leaf growth rate and life span.

The same populations, C6600 (doubled haploid) and m167 (highly heterozygous), as well as the same experimental conditions as the previous study were used. The C6600 population gave an estimate of the environmental variation and was used to estimate genetic variances.

Estimates of genetic variation (F ratios) in population m167 for growth rates of the first eight leaves are given in Table 2. Most estimates were significant. Genetic differences appeared to increase with age, suggesting that environmental differences in seed germination and emergence became less influential in older, larger plants.

Table 2. F ratios (s^2m_{167}/s^2C_{6600}) for growth rates in population m167 of the first eight leaves.

Growth Rate	Leaves			
Days from Planting To	1 and 2	3 and 4	5 and 6	7 and 8
1 cm in length	2.15**	0.27	0.25	2.03*
5 cm in length	0.75	0.20	1.41*	2.97**
10 cm in length	0.78	2.37**		
Death	1.44*			

* Significant genetic variation at P = 0.05.
** Significant genetic variation at P = 0.01.

Significant genetic variation existed for the life span of the first two true leaves (Table 2). This suggests that progress could be made by selecting in this character. Regression lines were constructed between life span of the first leaves with fresh root weight and dry root weight for the homozygous (C6600) and the heterozygous (m167) populations (Figs. 1 and 2). In both cases the regression line for the homozygous line was almost straight, whereas the regression line for the heterozygous population diverged significantly from a straight line. There appears to be sufficient genetic variation for this character to justify further investigation.

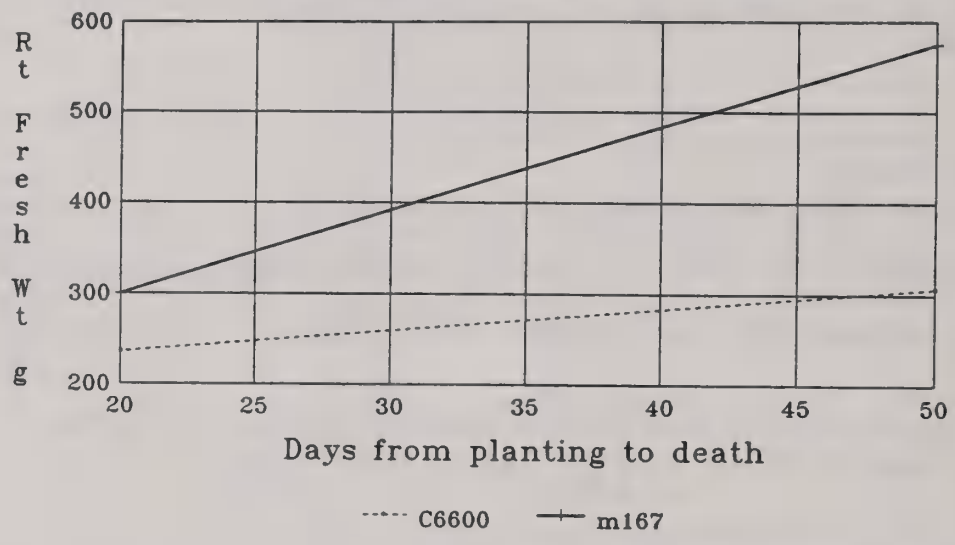
As a result of the above data, a selection criterion based on the green leaf duration of the first two leaves was initiated.

RHIZOCTONIA ROOT ROT RESEARCH

W. M. BUGBEE

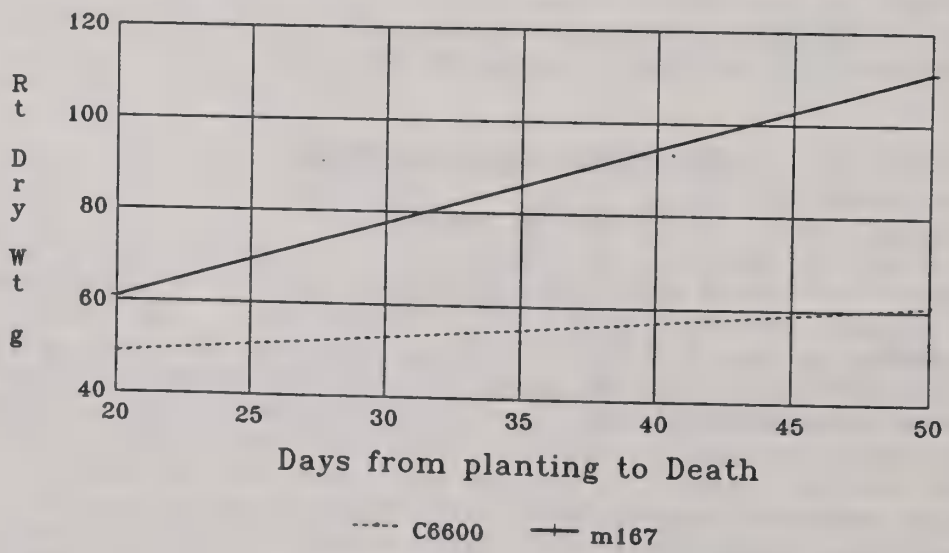
Introduction.--Root rot of sugar beet caused by the soil-borne fungus *Rhizoctonia solani* is present in nearly every field of sugar beet. The number of plants affected usually is few, but the disease has been increasing in prevalence in Minnesota and North Dakota to the point where many growers are concerned. The most efficient and economical control of root rot is the use of resistant hybrids which are becoming available to growers. Resistant hybrids often yield less than susceptible hybrids. More basic information on this host-pathogen relationship is needed in order to accelerate the breeding program and produce resistant varieties with acceptable yield. This report summarizes the past year's research on gathering some new information on an enzyme *Rhizoctonia* uses to cause root rot and the inhibitor the sugar beet uses to inactivate the enzyme.

Figure 1: Regression of green leaf duration with Fresh Weight



Note: Data is for first two leaves

Figure 2: Regression of green leaf duration with Root Dry Weight



Note: Data is for first two leaves

Results.--The cell-wall-destroying enzyme produced by *Rhizoctonia* that appears to have a major role in causing root rot is pectin lyase. This enzyme has been purified and partially characterized. Potential uses for this enzyme are: 1) amendment of sugar beet cell suspension cultures to select enzyme-resistant cells; 2) assay for an inhibitor of the enzyme; and 3) quick assay for root rot resistance in individual plants.

Amendment of cell suspension culture.--The objective of this project is to develop a method to quickly select root-rot-resistant plants through tissue culture. Surviving cells that are exposed to lethal doses of the appropriate enzyme should regenerate into whole plants that also are resistant to the enzyme as well as the fungus. Pectin lyase was toxic to sugar beet cells in a suspension culture. A high dose of the enzyme killed over 90% of the cells within 48 hours. If over 60% of the cells were killed, the surviving cells did not continue to grow. A critical mass of cells is required to initiate and maintain vigorous growth. There are methods to induce a small of number of cells to grow and these "nurse culture" methods are being tried now. In a recent trial, 50% of cells in a suspension of the regenerative line REL-1 were killed after exposure to pectin lyase. The treated cells were collected, washed, and placed in culture dishes with other vigorous, untreated calli. The treated mass of cells appears to be recovering and growing.

A pectin lyase inhibitor from sugar beet.--The objective of this project is to learn how resistant sugar beets defend against *Rhizoctonia* at the molecular level. The information may be useful in guiding future efforts to enhance resistance. Extracts from root-rot-resistant FC 712 were compared to root-rot-susceptible Monohikari for an inhibitor of pectin lyase. One ml of crude extract from the crown, hypocotyl, or root was mixed with the enzyme and allowed to set for 5 minutes to allow the inhibitor to bind to the enzyme. The mixture then was assayed for the ability to depolymerize a buffered pectin solution. The control assay mixture contained extraction buffer instead of tissue extract. The results showed that extracts from FC 712 inhibited pectin lyase 42-56%, whereas no inhibitory activity was detected in extracts from Monohikari. Purification of the inhibitor currently is in progress. The inhibitor is a protein because it can be precipitated with ammonium sulfate, fractionates on a gel chromatography column, and is deactivated by heat and proteolytic enzymes.

Quick assay for root rot resistance.--The objective here is to inject pectin lyase into sugar beet tissue to determine if root-rot-resistant plants respond less than susceptible plants. If a differential response occurs, then the method could be used to select and evaluate plants in a root-rot-resistance breeding program. Resistant FC 712 was compared with susceptible Ultramono. The enzyme was injected into the bases of petioles, into the petioles at the junction with the leaf blades, and infiltrated into leaves. Leaves of Ultramono wilted but not FC 712 when petioles were injected, but the response was not consistent. Sometimes leaves wilted and sometimes not. Leaves were very sensitive and responded quickly and uniformly when infiltrated with pectin lyase. The response was susceptible in both cultivars when a high dosage of pectin lyase was used. However, FC 712 gave a resistant reaction and Ultramono a susceptible reaction when pectin lyase was diluted and infiltrated into leaves. The susceptible reaction was cell death in that area of the leaf exposed to the enzyme. The response occurred with two hours. Plants with eight leaves did not express a differential response but plants with 16 leaves (5 weeks old) did show a differential response. When refined, the method could be used to evaluate plants

that have been regenerated from tissue culture and plant populations in the greenhouse. A plant could be evaluated within 5 weeks in the greenhouse compared to the current method of evaluating the response of inoculated plants in the field after an entire growing season. To my knowledge this is the first report of a quick method to identify root-rot-resistant plants by infiltration of an enzyme into leaf tissue.

STORAGE-ROT RESISTANT HYBRIDS

L. G. CAMPBELL

Over the past ten years considerable effort has been put into the development of storage-rot resistant germplasm. This research has included the adaptation of techniques that allow for the nondestructive screening of large numbers of individual roots and the examination of diverse germplasm sources. Five storage-rot germplasms have been released to commercial breeders. These germplasms were selected almost exclusively for their rot response and little is known about their performance as pollinator parents in hybrids.

The storage-rot resistant lines F1004, F1005, and F1006 were crossed with seven genetically diverse lines. The resultant hybrids, in general, exhibited higher levels of resistance to *Phoma betae* and *Botrytis cinerea* than their CMS parents but were not as resistant as the rot-resistant pollinators. Hybrids with SP69550-01 and FC 708 CMS as female parents were more resistant than hybrids involving the other lines. These lines possess resistance to Aphanomyces or Rhizoctonia and appear to provide increased resistance to storage-rot fungi in hybrids. Sucrose concentration of the susceptible/resistant hybrids was equal to four commercial hybrids and clear juice purity was slightly below that of the commercial hybrids. No negative association between storage-rot resistance and yield was detected. Yields were low because of poor stands caused by excess water during germination and early development.

Table 3. Performance of hybrids with storage-rot resistant pollinators, Fargo, North Dakota, 1987.

Designation	*Phoma*	*Botrytis*	*Penicillium*	Sucrose	Purity	Root Yield
	Rating[a]			%	%	Tons/A
Rot Resistant Parents:						
F1004	2.5p-t[b]	2.4i-j	0.3	9.8kl	84.2	2.8m-n
F1005	2.2st	2.4j	0.0	10.3j-h	86.1	6.0h-k
F1006	2.4r-t	2.3j	0.0	10.8h-l	83.7	6.2e-k
Mean	2.4	2.4	0.1	10.3	84.7	5.0

Table 3. Continued.

Designation	*Phoma*	*Botrytis*	*Penicillium*	Sucrose	Purity	Root Yield
	Rating[a]			%	%	Tons/A
Susceptible/Resistant Parents:						
SP69550/F1006	1.9tu	2.7h-j	0.1	12.1c-i	81.8	7.6d-i
SP69550/F1005	2.5q-t	3.3c-j	0.0	12.2c-i	87.7	9.7a-c
FC708/F1006	2.7o-s	2.4j	0.0	11.2f-j	88.0	9.7a-c
FC708/F1005	2.8n-s	2.7h-j	0.0	11.7c-j	86.2	7.9c-h
SP69550/F1004	2.8m-s	3.3c-j	0.0	11.8c-i	84.3	6.4e-k
C16/F1006	2.9m-s	2.7g-j	0.0	11.1f-k	83.2	10.6a
FC708/F1005	3.0k-s	3.0e-j	0.0	11.3e-j	87.1	7.9c-h
C16/F1004	3.3i-p	3.3c-j	0.0	9.8kl	83.9	8.0c-h
L53/F1005	3.3i-p	3.2c-j	0.0	12.4b-g	88.0	9.7a-d
C16/F1005	3.4i-o	3.6c-h	0.0	11.0g-k	86.4	7.4e-i
EL44/F1006	3.4i-o	3.4d-j	0.1	11.3e-j	86.1	7.2e-i
EL44/F1004	3.5i-m	3.7b-h	0.0	12.1c-i	87.8	6.0g-k
L53/F1004	3.5i-m	3.4c-j	0.0	11.5d-j	86.8	10.2ab
L53/F1006	3.6i-l	3.4c-j	0.0	11.6d-j	85.8	8.3b-f
EL44/F1005	4.0b-j	2.9e-j	0.0	11.7c-i	85.0	5.1j-l
Mean	3.1	3.1	0.0	11.5	85.9	8.1
Susceptible/Susceptible Hybrids:						
SP69550/L61	2.8n-s	3.8a-g	0.1	13.6ab	87.2	3.5l-n
SP69550/FC606	3.0l-r	4.2a-c	0.0	12.8a-d	85.3	6.4e-k
FC708/L61	3.2l-q	3.4c-j	0.0	13.0a-c	89.8	2.1no
FC708/FC606	3.3k-p	3.8a-g	0.0	11.7c-j	89.3	5.6i-k
C16/L16	4.0b-i	4.0a-g	0.0	12.1c-i	87.9	6.4e-k
EL44/FC606	4.1b-h	3.6b-h	0.1	11.5d-j	89.7	6.1f-k
C16/FC606	4.2b-g	3.9a-f	0.4	11.4e-j	89.9	8.1c-h
L53/L61	4.3a-f	4.1a-d	0.0	12.7a-e	85.4	6.8e-j
L53/FC606	4.4a-d	3.7b-h	0.0	12.3b-g	87.6	8.1c-g
EL44/L61	4.5ab	3.7b-h	0.3	12.5a-f	89.6	4.0l-n
Mean	3.8	3.8	0.1	12.4	88.2	5.7
Susceptible Parents:						
SP69550-01	1.6u	4.7ab	0.0	--	--	0.3o
FC708 CMS	3.1k-r	2.9e-j	0.0	12.4b-f	88.0	4.4k-m
L61	3.6e-l	3.2c-j	0.0	--	--	0.2o
C16 CMS	4.1b-h	3.7b-h	0.0	11.8c-i	90.1	2.9mn
FC606	4.4a-c	3.9a-f	0.1	9.6l	94.9	2.1no
EL44 CMS	4.6ab	4.8a	0.6	13.0a-c	92.9	2.1no
L53 CMS	4.9a	3.5c-i	0.0	13.7a	92.4	3.2l-n
Mean	3.8	3.8	0.1	12.1	91.7	2.2

Table 3. Continued.

Designation	*Phoma*	*Botrytis*	*Penicillium*	Sucrose	Purity	Root Yield
	Rating[a]			%	%	Tons/A
Ultramono	3.5h-n	3.6b-h	0.0	12.2c-h	87.0	7.0e-j
Beta 1230	3.6e-k	3.8a-h	0.0	11.4e-j	87.1	7.7c-i
BJ-19	3.7e-k	2.8f-j	0.0	10.8e-l	85.6	6.7e-j
Monohikari	4.3a-e	4.2a-c	0.4	11.7c-i	85.1	8.4b-e
Mean	3.8	3.6	0.1	11.5	86.2	7.5

[a]Rot ratings from 0 = no rot present to 5 = completely rotted.

[b]Means of 6 replicates; means within a column followed by a common letter are not significantly different (P=0.05) according to Duncan's multiple range test.

COMBINED RESISTANCE TO ROOT AND STORAGE ROTS

W. M. BUGBEE and L. G. CAMPBELL

Several cultivars with resistance to root rot caused by *R. solani* or storage rot caused by *Phoma betae* and *Botrytis cinerea* were tested for their resistance to *R. solani* in three greenhouse tests and one field test. The same cultivars also were tested for their reaction to *P. betae* and *B. cinerea* in a storage rot test. The data in Table 4 show the results for the field and storage rot experiments. The field experiment confirmed the conclusions that were drawn from the greenhouse experiment. Monohikari and C-16 were the susceptible checks and had the highest disease ratings for both root rot and storage rot. FC 712 had the highest resistance to root rot as shown by the lowest disease index. FC 712 also expressed resistance to storage rot. The germplasm lines F 1002, F 1004P, and F 1004G which were developed for resistance to storage rot also expressed resistance to root rot. The resistance was comparable to the root-rot-resistant ACH 139. ACH 139 expressed moderate resistance to storage rot. Therefore, germplasms that were developed at Fargo for resistance to storage rot caused by *P. betae* and *B. cinerea* were discovered to be moderately resistant to *R. solani*. And a germplasm line developed at Fort Collins for resistance to *R. solani* expressed moderate resistance to *P. betae* and *B. cinerea*. This unexpected multiple resistance indicates that commercial root-rot-resistant cultivars should store better than nonselected cultivars.

Table 4. The reaction of cultivars to storage rot caused by *Phoma betae* and *Botrytis cinerea* and to root rot caused by *Rhizoctonia solani* as shown by a root and storage rot disease index (DI).

Cultivar	Root Rot Disease Index[a]	Stand Loss	Storage Rot Disease Index[b]	
			Phoma	*Botrytis*
	DI	%	DI	DI
FC-712	0.98	10.25	2.1	1.1
F1002	2.68	22.75	2.2	1.4
F1004P	2.80	23.25	1.7	1.1
F1004G	3.42	37.25	2.0	0.8
ACH-139	3.47	30.25	3.1	3.0
F1005	4.62	51.50	2.3	0.9
F1006	5.32	62.50	1.6	1.6
ACH-146	5.62	61.00	3.1	2.0
F1009	5.72	71.25	2.2	1.4
Monohikari	6.28	81.00	4.2	4.3
C-16	6.75	93.50	3.4	3.3
LSD, 0.05	0.88	16.25	0.6	0.6

[a] The mean root rot disease index from four replicates is on a scale of 0 - 7 with 0 = healthy and 7 = dead.

[b] The mean storage rot disease index from four replicates indicates the distance rot progressed through a 1 cm block of root tissue during 2 weeks at 22 C: 0 = 0 mm; 1 = not over 2 mm; 2 = 2-4 mm; 3 = 4-6 mm; 4 = 6-8 mm; 5 = entire block.

GERMPLASM ENHANCEMENT

D. L. DONEY

Evaluation of the NC-7 Collection: This is an ongoing project to evaluate the NC-7 collection for priority descriptors as determined by the Sugarbeet Crop Advisory Committee. Each accession is evaluated for the following descriptors:

Root maggot resistance - Anderson
Agronomic (yield, % sugar) - Doney and Kern
Rhizoctonia resistance - Hecker
BWYV resistance - Lewellen
Curly Top resistance - BSDF
Cercospora resistance - Smith
Rhizomania resistance - Whitney
Nematode resistance - Yu

This report covers the agronomic tests conducted by Doney and Kern in the summer of 1988. A total of 58 accessions were evaluated in two separate tests. Each test was replicated four times in single row plots. All plots were hand dug and topped. Pictures (longitude and cross section) were taken of each accession. The entries consisted of many types (fodder, red, sugar, etc.). Results of the tests are given in Tables 5 and 6. Data are presented in percent of the mean of the three checks (Ultramono, SP7622-0 and L19). The extreme dry conditions of the summer of 1988 resulted in low yields and sugars; however, comparisons with the checks are statistically relevant. The fodder beets were very low in sugar and high in root yield (note PI285592-PI285594), whereas the red beets were low in both sugar and yield (PI164810). Several lines from the People's Republic of China (A8048-A8055) exhibited good sugar and fair yield. These are open-pollinated multigerm lines. All the evaluation data are entered into the Germplasm Resources Information Network (GRIN) and can be accessed via computer.

Evaluation of the British Isles Collection of Beta maritima: The collection objective of the 1987 expedition in England, Wales and Ireland was to collect and preserve the genetic variation existing in the native populations of *Beta maritima*. Since it was impossible to collect everything, a stratagem was developed to collect every 15 to 25 kilometers. All collections were bulk except where obvious variants were present. In these populations both bulk and individual collections were made.

Most of the bulk populations were grown in a field trial at Fargo, North Dakota, during the summer of 1988 for preliminary characterization. Each population with sufficient seed was planted in a single 20-foot row. A commercial hybrid check (Hilleshög 5135) was also included as a reference. Supplemental irrigation resulted in good stands for most of the accessions even though germination was slow. This slow germination was expected since *Beta maritima* is noted for seed dormancy or germination inhibition effects.

North Atlantic *Beta maritima* have been reported to behave much as perennials, i.e., producing seed stalks for several years. Our observations substantiated this. Seed was sometimes found on the first year's growth, but it was generally late and immature. In Fargo, no seed or flower buds were produced on the first year's growth even though nearly all accessions produced prostrate flower stalks. Leaf measurements were taken in mid-August after maximum leaf expansion and prior to stalk initiation. The most mature non-senescent leaves of each plant were measured for leaf thickness, length and width; petiole length and width; leaf dry weight; and dry weight percentage. There were significant differences between the accessions for each of the characters. All accessions had significantly thicker leaves than the sugarbeet check, with some over twice as thick. The leaves were, however, smaller than sugarbeet in both length and width. When the total dry matter per leaf was compared to sugarbeet, they were still smaller. Petiole length and width were also smaller than sugarbeet.

A negative correlation ($r = -0.52$) between leaf thickness and leaf percent dry matter resulted in lower leaf dry matter percentage for the *Beta maritima* accessions than for sugarbeet.

Population Dynamics of the British Isles Collection: The collection of individual plants within each population made it possible to study population dynamics. Populations at seven different collection sites, each about 15-20 kilometers apart, were studied in detail. The study consisted of 10 plants from each of 10 collection plants at each location. Measurements were made for leaf thickness,

Table 5. Evaluation data for 32 accessions in replicated (4 reps) field trials (Moorhead, Minnesota). Data is presented as percent of the mean of 3 checks.

Description	Sucrose %	Yield T/A	Rec S lbs/T	Rec S lbs/A	Na ppm	K ppm	AmN ppm
Check means	15.2	13.3	264	3487	448	2772	683
*Ultramono	103	126	103	130	95	104	103
*SP 7622-0	91	109	90	101	112	98	100
*L19	106	64	108	71	93	98	97
PI 116906	61	100	52	52	125	134	108
PI 117114	72	109	61	67	146	141	133
PI 140360	64	220	54	118	166	119	129
PI 141918	70	140	60	84	117	129	143
PI 142818	60	158	48	76	180	136	132
PI 163182	48	132	36	49	179	134	96
PI 164805	32	89	19	18	163	135	89
PI 164810	27	67	14	10	151	134	66
PI 165485	54	68	46	31	155	131	69
PI 167374	63	122	49	62	156	153	146
PI 169023	40	111	27	30	239	127	96
PI 169030	66	131	58	78	168	122	95
PI 169032	62	118	52	61	178	127	107
PI 171520	72	105	64	69	130	127	111
PI 176424	76	142	66	95	113	130	108
PI 204678	72	124	63	78	137	127	132
PI 206407	75	74	68	51	122	111	127
PI 220645	94	119	90	106	133	126	111
PI 222970	86	144	80	116	126	113	129
PI 232887	56	175	44	77	196	138	109
PI 232889	67	164	57	93	187	134	129
PI 232890	49	252	37	93	232	128	111
PI 248503	51	46	41	19	154	150	71
PI 266100	102	78	101	80	115	101	121
PI 266101	90	102	83	86	114	140	136
PI 274394	103	87	104	91	80	106	94
PI 285589	54	92	45	43	158	131	78
PI 285590	51	117	40	47	201	138	86
PI 285591	53	73	43	31	154	137	83
CV %	7.1	14.6	9.9	17.5	14.8	6.7	9.7
LSD (0.05)	6	24	8	17	31	12	14

* Checks

Cooperative study between USDA-ARS and American Crystal Sugar Co.

Table 6. Evaluation data for 32 accessions in replicated (4 reps) field trials (Moorhead, Minnesota). Data is presented as percent of the mean of 3 checks.

Description	Sucrose %	Yield T/A	Rec S lbs/T	Rec S lbs/A	Na ppm	K ppm	AmN ppm
Check means	14.9	12.3	259	3195	396	2737	659
*Ultramono	107	113	109	124	80	102	96
*SP 7622-0	93	117	92	108	113	97	104
*L19	100	70	99	69	107	101	100
PI 285592	47	224	33	72	270	140	111
PI 285593	63	175	51	91	166	146	126
PI 285594	54	204	41	81	233	143	121
PI 285595	51	208	38	79	234	133	117
PI 293419	41	92	29	27	175	152	73
PI 323938	47	103	35	36	156	137	108
PI 355958	96	106	93	98	115	112	134
PI 355961	102	108	100	107	94	116	110
PI 355962	94	99	88	87	105	138	127
PI 355963	95	119	91	108	115	130	118
PI 357351	57	50	49	25	124	137	79
PI 357357	27	108	11	12	201	150	101
PI 357360	53	178	41	73	218	132	115
PI 357361	56	137	43	60	210	132	138
PI 357367	76	64	65	41	158	115	178
PI 467869	112	62	114	70	66	100	98
PI 467870	111	79	113	90	73	101	97
PI 467871	99	88	98	87	86	101	115
PI 467874	104	99	105	104	72	106	102
PI 467875	104	102	105	107	80	96	94
PI 467876	105	74	105	78	76	98	104
A 8048	104	77	106	82	63	93	103
A 8049	106	88	108	95	68	92	107
A 8050	105	83	106	89	84	97	104
A 8051	104	100	104	104	66	100	113
A 8052	103	102	103	104	76	98	124
A 8053	104	99	104	103	72	99	119
A 8054	109	89	111	99	75	92	107
A 8055	110	87	112	98	61	99	101
CV %	5.3	12.2	7.0	14.9	16.1	5.0	9.2
LSD (0.05)	6	18	8	17	27	8	14

* Checks

Cooperative study between USDA-ARS and American Crystal Sugar Co.

length and width; petiole length; and leaf osmotic pressure. Two inbreds (L53cms and L19) were included in the osmotic pressure measurements. Earlier studies had identified the high sugar inbred L19 as possessing a higher osmotic pressure than most other sugarbeet lines.

Locations Pegwell Bay, Deal and Dover are on the southeastern coast with the Deal location between Pegwell Bay and Dover. Significant differences were found for all leaf characteristics between Pegwell Bay and Dover. Deal, however, contained characteristics of both Pegwell Bay and Dover populations (Fig. 3). Each leaf measurement at the Deal location was between the locations on either side (Pegwell Bay and Dover). At 15 kilometers, changes in gene frequency were observed but were not sufficient to form a new ecotype. However, at distances of greater than 30 kilometers, isolation was sufficient to shift gene frequencies and enhance formation of distinct ecotypes.

Older populations exhibited more variation than younger populations. One such population was located at Dover. There were significant differences between plants within this population for most measurements. The measurements for leaf thickness at this location is shown in Figure 4. The plants fell into three significantly different groupings for leaf thickness. In addition, six of the 10 plants were segregating for leaf thickness (Fig. 4). There appears to be significant intercrossing and segregation taking place between plants within this population.

Data for the five leaf measurements at the seven locations are shown in Figures 5, 6 and 7. Non-significant differences between nearest-neighboring populations (NS) were more prevalent for petiole length than for the other characteristics. However, at least two leaf characteristics were significantly different between each two nearest-neighbor locations.

Leaf osmotic pressure (Fig. 8) also changed significantly between the populations. Locations on the southern coast were generally the highest. The L53cms inbred is representative of most sugarbeet germplasm. Only one population (Deal) gave osmotic pressure readings less than L53cms. All others were higher in leaf osmotic pressure. Sugarbeet inbred L19 gave the highest reading of all. However, many plants in populations at Gladstone and Chamber were equivalent to L19. Presumably, the high osmotic concentrations in the *Beta maritima* populations are an adaptation to the saline environment. If this high osmotic potential could be transferred to sugarbeet, higher sugar concentrations may be possible.

FIGURE 3: LEAF CHARACTERISTICS PEGWELL BAY TO DOVER

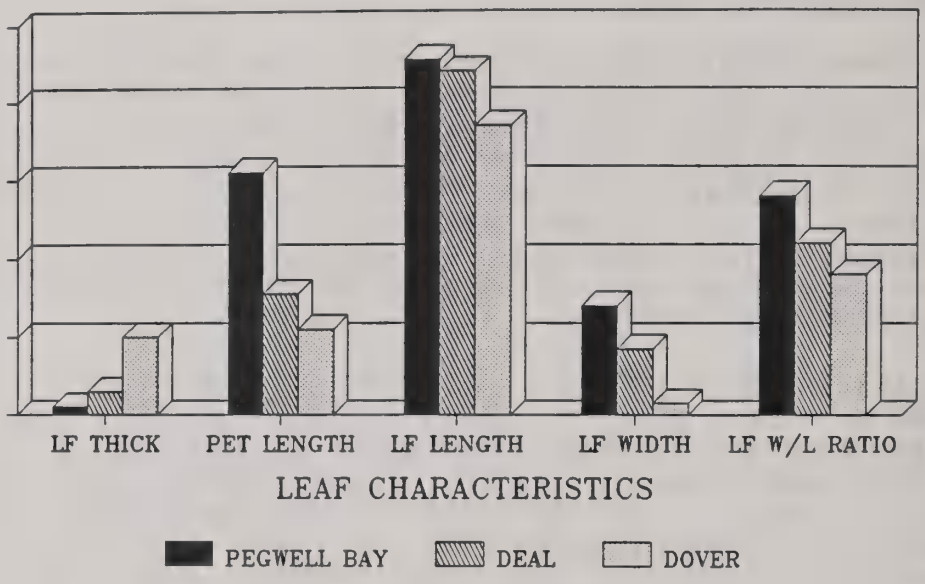
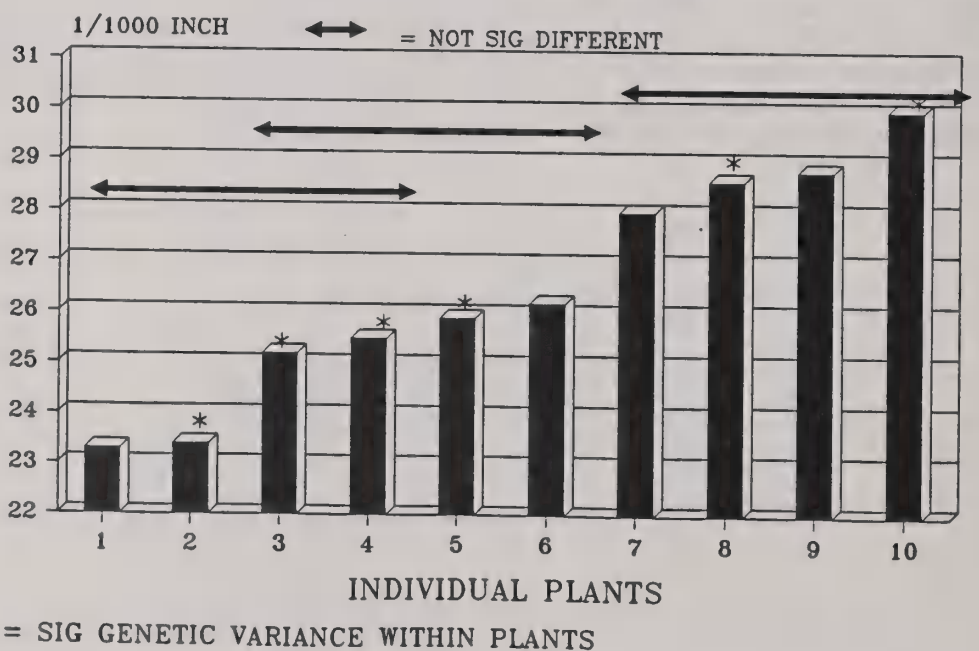
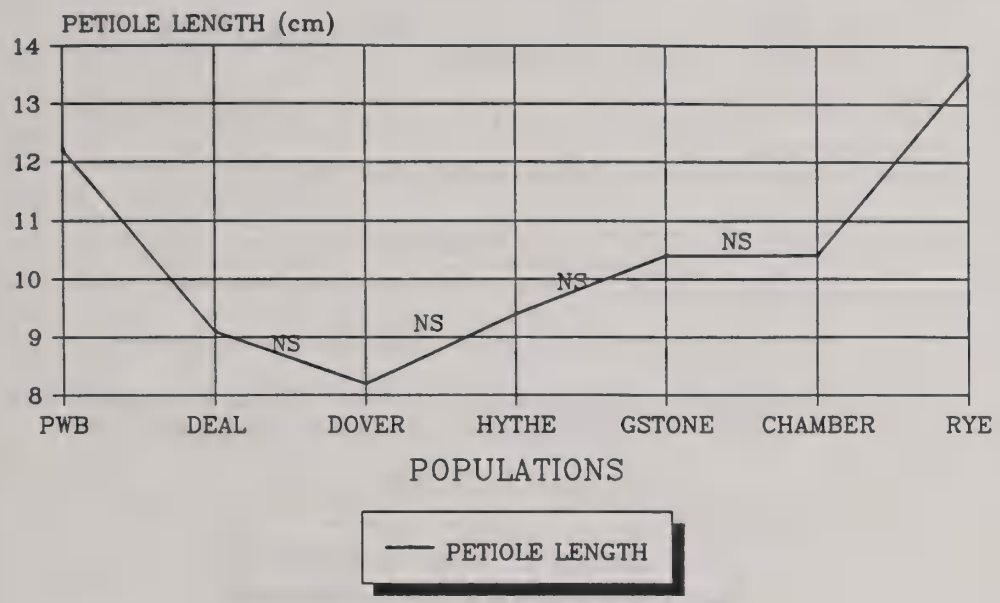


FIGURE 4: LEAF THICKNESS DOVER POPULATION



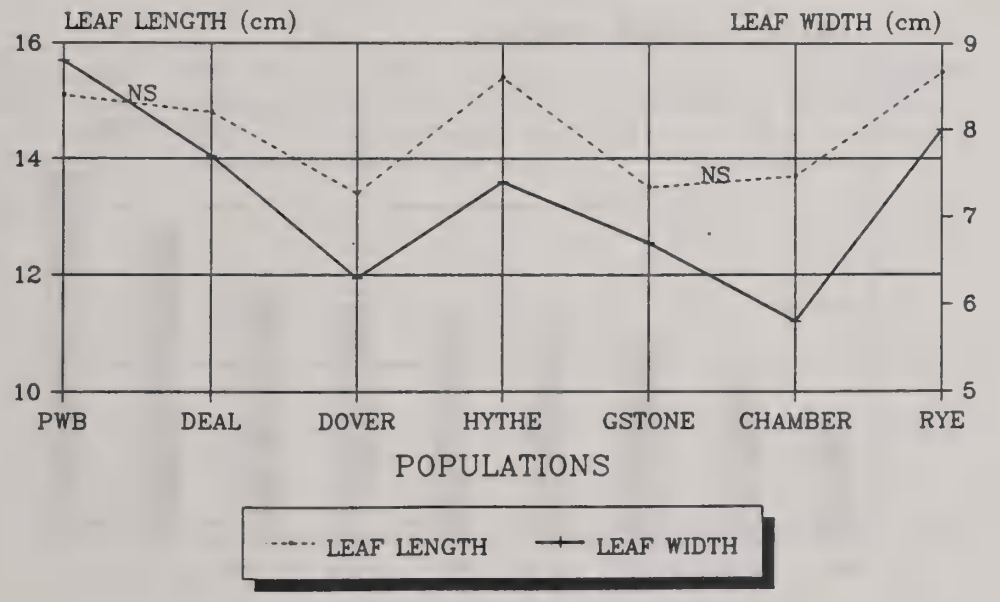
* = SIG GENETIC VARIANCE WITHIN PLANTS

FIGURE 5: PETIOLE LENGTH POPULATIONS FROM PEGWELL BAY TO RYE



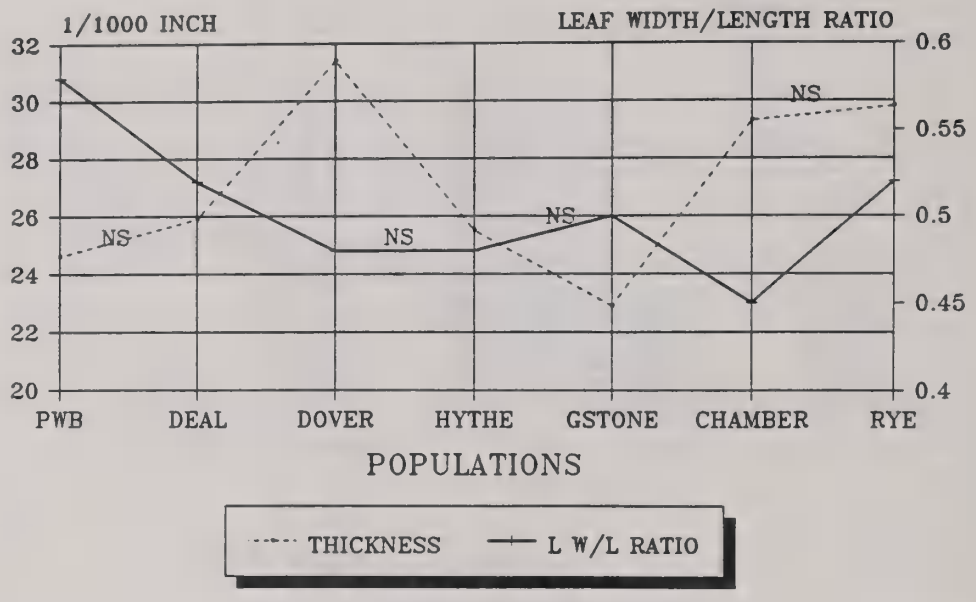
NS=NON-SIGNIFICANT BETWEEN NEIGHBORS

FIGURE 6: LEAF LENGTH & LEAF WIDTH POPULATIONS FROM PEGWELL BAY TO RYE



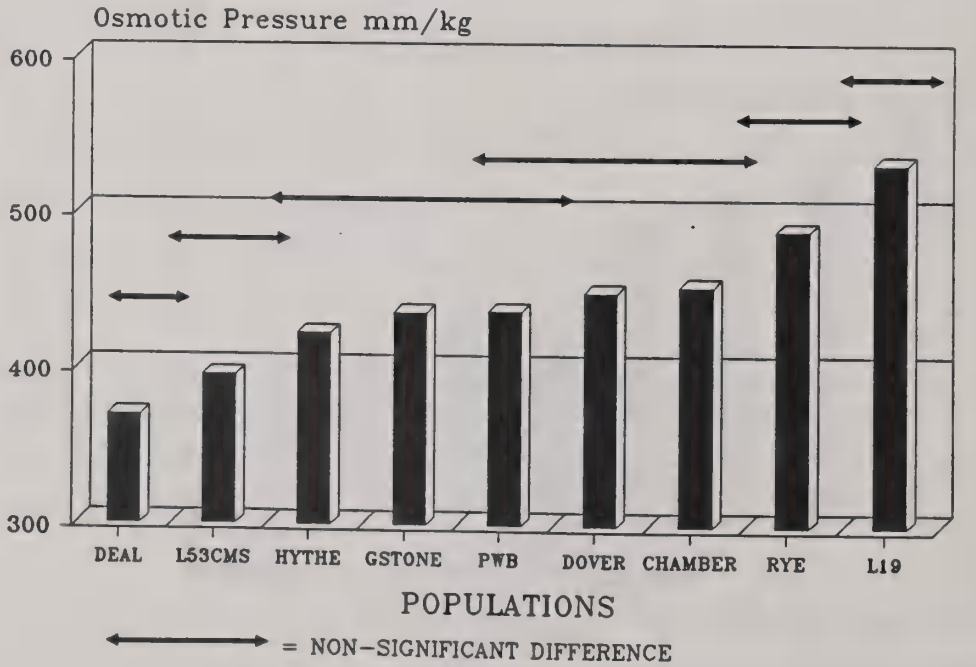
NS=NON-SIGNIFICANT BETWEEN NEIGHBORS

FIGURE 7:LEAF THICKNESS & LEAF L/W RATI POPULATIONS FROM PEGWELL BAY TO RYE



NS=NON-SIGNIFICANT BETWEEN NEIGHBORS

FIGURE 8: LEAF OSMOTIC PRESSURE PEGWELL BAY TO RYE & TWO SB INBREDS



SUGARBEET RESEARCH

1988 Report

Section E

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CONTENTS

SOMATIC CELL SELECTION

J. W. Saunders

Chlorsulfuron Resistance

Characterization of chlorsulfuron resistance obtained from plated out suspensions of clone REL-1 was begun using ramets of the resistant shoots as well as progeny. A greenhouse test of REL-1 and the resistant isolate CR1-B using soil incorporated Classic ® herbicide (the active ingredient is a chemical analog of chlorsulfuron) demonstrated at least eight-fold greater resistance of CR1-B than REL-1 when a dilution series was used. CR1-B showed no damage symptoms at even the highest rate used (1 oz/acre), but in retrospect it was concluded that the tissue culture-derived ramets were too large for damage to occur to CR1-B plants at the rates chosen. Thus, the full magnitude of the resistance difference could not be determined in that test.

Other greenhouse tests employed S_1 or F_1 seedlings, with post-emergence or pre-emergence soil application. Under the model of monogenic resistance with heterozygosity in the shoots from the selected callus, S_1 and F_1 families would segregate for resistance. This pattern was seen, although most tests had enough environmental variability (damping off, etc.) to interfere with clean genetic ratios. In conjunction with this, application of different rates of the herbicide led to different survival rates within the same families. The sulfonylurea herbicides do incur breakdown in soil solution, and what may have been determined to be the ideal herbicide rate one month in the greenhouse may not be ideal later when temperatures are different. Overall, these greenhouse methods of evaluation could produce inheritance patterns interpreted as quantitative. An additional disadvantage of working with progeny seedlings in the greenhouse was that susceptible plants that died could not be retested for a confirmation of phenotype.

The one field evaluation performed had the same drawback. F_1 progeny resistant to Classic (0.05 lb a.i./acre) were recovered from the test where a commercial hybrid was intensely affected (i.e., no beets emerged). There could be no count of susceptible F_1 segregates in the test.

Surviving beets from this field test were dug in September and brought into the greenhouse. The population segregated for annualism, and about 20 plants were cloned via shoot culture from floral stalk buds. Multiple shoots then were challenged in controlled tests with 0 or 28 nM chlorsulfuron in vitro. The results of this test were very clear-cut. All shoots from surviving F_1 field plants showed no damage, whereas all shoots from control susceptible plants died within 10 days. In other words, chlorsulfuron resistance seen in the field was also seen in vitro.

Nineteen S_1 plants were cloned in vitro prior to being used for test crosses with a susceptible CMS line. All 19 tested resistant on 28 nM chlorsulfuron in vitro. This was a little unexpected, as a random sample of the S_1 generation should segregate 3:1 (resistant:susceptible) if the aforementioned model were correct. These S_1 individuals, however, were not randomly chosen. Segregates for biennialism and for barren seed stalk,

present in the S_1 of REL-1, had been rogued out. The possibility that a linkage exists between the annual gene B and chlorsulfuron resistance is discounted because annualism segregated approximately 1:1 in the field test survivors.

In conclusion, (1) chlorsulfuron resistance has behaved in a dominant fashion in progeny, (2) the cell selected resistance is at least 8-fold greater than with the controls, and (3) in vitro evaluations are less variable and more reliable than greenhouse tests, but also more labor-intensive.

The collaboration of Michigan State University weed scientists Don Penner and Karen Renner is gratefully acknowledged.

Development of Germplasm for use in Somatic Cell Selection

REL-1 was released to the public in 1987 as a model clone for beet tissue culture genetic manipulations. Its advantages are its good shoot regeneration ability, good suspension making, annualism, and self-fertility. It is also a diploid. But its drawbacks are segregation for biennialism and for barren floral stalk. One approach is to select an S_1 individual that is homozygous annual and does not segregate for barren stalk. This comes at the cost of somewhat reduced vigor and possible segregation for poor tissue culture properties. Vigor is considered important because unintended somaclonal variation after future cell selection attempts could further reduce vigor and provide a hindrance to good fertility in selected plants. This first approach is being pursued. Additional effort has gone into attempts to produce a successor to REL-1 that incorporates vigor and elite breeding value, eliminates the previously mentioned reproductive disadvantages, and yet retains the favorable properties.

Ovule Culture of REL-1

A haploid tissue culture compliant annual clone would be helpful in recovering recessive forms of genetic variation selected for in somatic cell selection efforts. Dominant forms of variants are selectable when diploids are used, but ability to recover recessive forms widens the range for available biochemical mechanisms of resistance. Thus, using the mother clone REL-1, we set out to produce gynogenetic haploids by culturing immature ovules, a technique that has been developed in other labs. We intended to produce a good number of haploids so we could choose the best combination of segregating characters.

At the onset, it was decided to try standard media routinely available in the lab. This was because there was little indication of large medium effects in the literature. We used Murashige-Skoog (MS) inorganic salts mix with organic additives as in Crop Sci. 22:1102-1105 (1982) with either 0.25 or 1.0 mg/l 6-benzyladenine (BA). The ovules were sampled over a five-month period from June to November from the greenhouse. In addition to the confounding of seasonal effects (the greenhouse environments covered a range of extremes of temperature and light intensity) on mother plant, there were variations in temperature and light intensity during culture of the ovules.

Several potential patterns were seen from the results, where 16 potentially haploid shoot cultures and a half-dozen calli were produced from nearly

6000 ovules. First, 0.25 mg/L BA produced embryos with very little callus. BA at 1.0 mg/L gave callus or embryos which callused intensely. Because callus is at risk to produce shoots of reduced vigor, the 0.25 mg/L BA is recommended. Secondly, mother plants grown in moderate greenhouse conditions seemed to yield responding ovules at a higher frequency than plants grown in high temperature or low light intensity. The low overall response in terms of embryo per ovule plated should be considered in light of nonoptimized ovule stage as well as extreme greenhouse environments. However, once a suitable haploid is obtained, this can be perpetuated by shoot culture.

ISOENZYME STUDIES

J. W. Saunders, L. D. Aicher, J. C. Theurer, and G. Acquaah

Isoenzymes are multiple functional forms of enzymes that are separated by an electric current due to differential charges on the enzyme molecules. Visualization of the forms of the enzyme with differential mobilities occurs after staining. The number of enzyme systems suited for use in research of this kind is limited to those for which stains have been identified. Actually, this is only a small proportion of the enzymes known to be active in the plant. From a genetic perspective, the utility of isoenzyme analysis is also limited by the number of enzyme loci displaying variation in mobility. Some enzymes are encoded by only one locus. Some enzymes are encoded by multiple loci, but are compartmentalized within specific organelles. Isoenzymes can differ in tissue specific expression, and can have one, two, four, or more subunits, sometimes encoded by more than one locus. Obtaining clear reliable isoenzyme patterns can become something of an art.

We have developed an interest in isoenzymes for several reasons: (1) to provide a means of clonal fingerprinting for genetic and breeding applications, (2) to develop linkage information, especially in relation to new traits arising from tissue culture research, and (3) to provide information on evolution of species and subspecies and their domestication.

Simple inheritance with incomplete dominance has been determined with one locus of malic enzyme (ME), two loci of malate dehydrogenase (MDH), one of phosphoglucomutase (PGM), and one of shikimate dehydrogenase (SKDH). In addition, inheritance of a band pattern, probably corresponding to one of two loci, has been established for isocitrate dehydrogenase (IDH).

Two likely loci have given aberrant segregation ratios. Phosphoglucoisomerase (PGI) produces skewed ratios in some progenies. A tentative hypothesis is that PGI is linked to a self-incompatability locus. Glutamate dehydrogenase (GDH) has not behaved as expected, as no heterozygous pattern has been visualized when anticipated. GDH has only been examined for progeny of one cross.

Isoenzyme research in sugarbeet has been reported recently by workers in Japan, Belgium, and the Soviet Union. There is not full agreement on

interpretation of the more complex patterns, particularly where all loci are not genetically variable. Details of our work, including linkage studies and isoenzyme expression in pollen, will be available in upcoming publications.

MOLECULAR STUDIES ON MITOCHONDRIAL DNA AND RNA OF SOME CYTOPLASMIC MALE STERILE LINES OF SUGARBEET

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Cooperative research with molecular scientists at Michigan State University and the Hebrew University in Jerusalem, Israel, were continued in 1988 in an effort to gain further understanding concerning the molecular nature of cytoplasmic male sterility in sugarbeet. Earlier reports (1986 Research Report, Page E17, and 1987 Research Report, Page E6) have summarized former years results in comparison of N = Normal, S = Owens CMS, BMC = Beta maritima L. CMS, and S_i-2, S_i-3, S_i-4 CMS derived by gamma irradiation by Kinoshita and Takahashi (1969). Briefly, endonuclease restriction polymorphisms (RFLP) of mitochondrial DNA demonstrated that BMC-CMS was different than S but S_i-2, S_i-3, and S_i-4 were identical to S molecularly.

The mitochondria are recognized as the sites where cell respiration occurs. Studies with yeast, Neurospora, and maize have demonstrated that all mitochondria contain multi-subunit assemblies of respiratory enzymes. Some of these are partly encoded by mitochondrial genes. Two large subunits of cytochrome oxidase, COX I and COX II, and ATP6 and ATP9 genes of the ATPase complex are encoded by mitochondrial genes. Research indicates that these four genes may be implicated in the basic causal mechanisms of cytoplasmic male sterility. CMS-T in maize has been found to be caused by a mitochondrial gene labeled as urf13-T. This gene is a 3547 bp fragment formed by rearrangements involving a flanking region of the ATP 6 gene and coding regions of the maize mitochondrial 26 S ribosomal gene and the chloroplast tRNA-Arg gene (Dewey et al., 1986, 1987; Levings et al., 1988). The urf13-T gene produces two mRNA transcripts, one of which is unique to CMS-T and is altered by the action of the Rf_1 restorer gene (Dewey et al. 1986). The male-sterile cytoplasm of CMS-C of maize contains mutations of the mitochondrial genes ATP 9, ATP 6, and COX II (Levings et al. 1988). Upstream sequences and the first 65 amino acids of the ATP 6 gene have been found spliced in front of the COX II gene. A rearrangement in which parts of the ATP 9 gene, the COX II gene, and an unidentified open reading frame have recombined, has been found in petunia. Transcripts from this recombination originate from three starting points upstream of the ATP 9 gene (Hansen, unpublished). Rearrangements in the COX I gene have been implicated in the 9E CMS of sorghum (Bailey-Serres et al. 1986).

Since the four mitochondrial genes, COX I, COX II, ATP 6, and ATP 9 were implicated in maize, petunia, and sorghum CMS, it would be logical to suppose rearrangements in these genes could also be the basic cause for the molecular lesions that cause CMS in sugarbeet. In 1987 and 1988, this hypothesis was studied using the maize mitochondrial genes as probes. In

addition, since there is a possibility that the genes governing CMS may only be active in floral tissue or in the gametophyte, buds, anthers, and pollen were studied molecularly to discern the relative size of the mRNA transcripts during flower development.

Methods

Molecular research was continued with N, S, S_i-4, and BMC cytoplasms recognizing that S and S_i-4 were of similar molecular genetic constituency. Mitochondria were isolated from roots of sugarbeet grown in the field or in the greenhouse. Mitochondrial DNA (mt DNA) and mitochondrial RNA (mt RNA) were isolated by standard methods outlined by Maniatis et al. (1982). Southern blot hybridization was carried out in 1987 using radioactive COX I, COX II ATP 6, and ATP 9 maize mitochondrial gene probes to discern DNA fragment hybridization. Northern blot hybridizations were conducted in 1988 using the same four radioactive maize gene probes to discern mRNA transcription relative to these mitochondrial encoded genes. Southern and northern blots were conducted in accord with standard methods (Maniatis et al. 1982).

A slot blot technique was used to study the quantity of mRNA transcribed in S vs. N plasms. Small floral buds and young anther tissue were removed from 30-40 CMS or N plasm plants by hand, using tweezers. Pollen samples from fertile flowers, and anthers from CMS flowers at anthesis, were collected 2 - 3 times weekly using a small vortex vacuum pollen-collecting tool. Daily collections were stored in a freezer, and composite samples were made of like tissues to obtain sufficient RNA for testing of six samples:

Fertile	(1) Bud	(2) Anther	(3) Pollen
CMS	(4) Bud	(5) Anther	(6) Older anther

Buds, pollen, or anthers were ground in a cold mortar and pestle in a 10mM Tris pH 7.6, 15 mM NaCl, 15 mM EDTA buffer with 2% sarcosyl and extracted with phenol and chloroform. The nucleic acids were extracted and a DNAase treatment was used to eliminate contaminating DNA. A slot blot apparatus was utilized to apply a given quantity of 0.5, 1.0, or 5.0 µg of pooled mRNA directly to the nitrocellulose filters. Standard northern blot hybridization techniques using the radioactive probes of ATP 9 and COX II were carried out to investigate the size of the RNA transcripts.

Results

The polymorphisms for the hybridization of sugarbeet mtDNA with the maize mitochondrial gene probes were discussed in detail in the 1987 Research Report, page E6. Briefly, differences were observed in hybridization patterns for sugarbeet mtDNA hybridized with COX II and ATP 9 genes. There were no RFLP differences with the COX I gene, and the ATP 6 gene gave variable non-conclusive results Part of the problem with the ATP 6 gene was the failure to obtain complete restriction with the Bam H1 endonuclease. The results of hybridization of mRNA with the four maize gene probes for N, S, S_i-4,and S_i-4 Rf cytoplasms are shown in schematic diagrams in Fig. 1.
Hybridization with the COX I (Fig. 1A) and the ATP 9 (Fig. 1D) genes showed similar transcripts for all cytoplasms. This suggests that these two genes

are not involved in CMS in sugarbeet. All four plasms had a 1700 nucleotide (nt) transcript when probed with the COX II gene (Fig. 1B). The N plasm had a 1180 nt transcript that was absent from the three other cytoplasms. S, S_i-4, and S_i-4 Rf each had a larger transcript (2200 nt) not found in the N type. There was no indication that the Rf gene affected transcription. A strong 2600 nt transcript was observed for the ATP 6 gene in N cytoplasm, but it was absent in all other plasms. These data and results from other molecular studies suggest that a rearrangement in the COX II gene may be a factor influencing CMS in sugarbeet.

In Fig. 2, schematic diagrams of the autoradiograms showing hybridization of the maize gene probes with N, BMC and BMC-Rf are given. The COX I (Fig. 2A) and ATP 9 (Fig. 2D) genes again exhibited no differences in transcripts, suggesting a lack of association of these genes with CMS in sugarbeet. The N and BMC-Rf cytoplasms show a similar transcript of 3000 nucleotides when hybridized with the maize COX II gene probe (Fig. 2B). However, the BMC source had a larger transcript of 3600-3900 nucleotides. Hybridizations with the APT 6 gene showed different transcripts for each of the three cytoplasms tested. The BMC had two transcripts compared to a single transcript for N or the BMC-Rf lines.

Slot blots are shown in Fig. 3 for S versus N plasms probed with the ATP 9 maize gene, and in Fig. 4 for the COX II maize gene. There appears to be a developmental down regulation from buds to anthers to pollen, or buds to young anthers to old anthers in the case of CMS. Gene expression is similar with the ATP 9 gene for both N and S cytoplasms, again suggesting that ATP 9 is not involved in CMS in sugarbeet. There appears to be an increased level of transcription in CMS plasm versus N plasm for the COX II gene expression at the bud and early anther stage of development.

In conclusion, it is probable, as has been demonstrated in maize and petunia, that CMS in sugarbeet is governed by a chimeric gene formed by rearrangement of DNA segments that result in an altered transcription. Results to date indicate that a rearrangement in the COX II gene may be associated with CMS in sugarbeet. Considerable additional research will be required before we can positively delineate the molecular basis of the different CMS plasms of sugarbeet.

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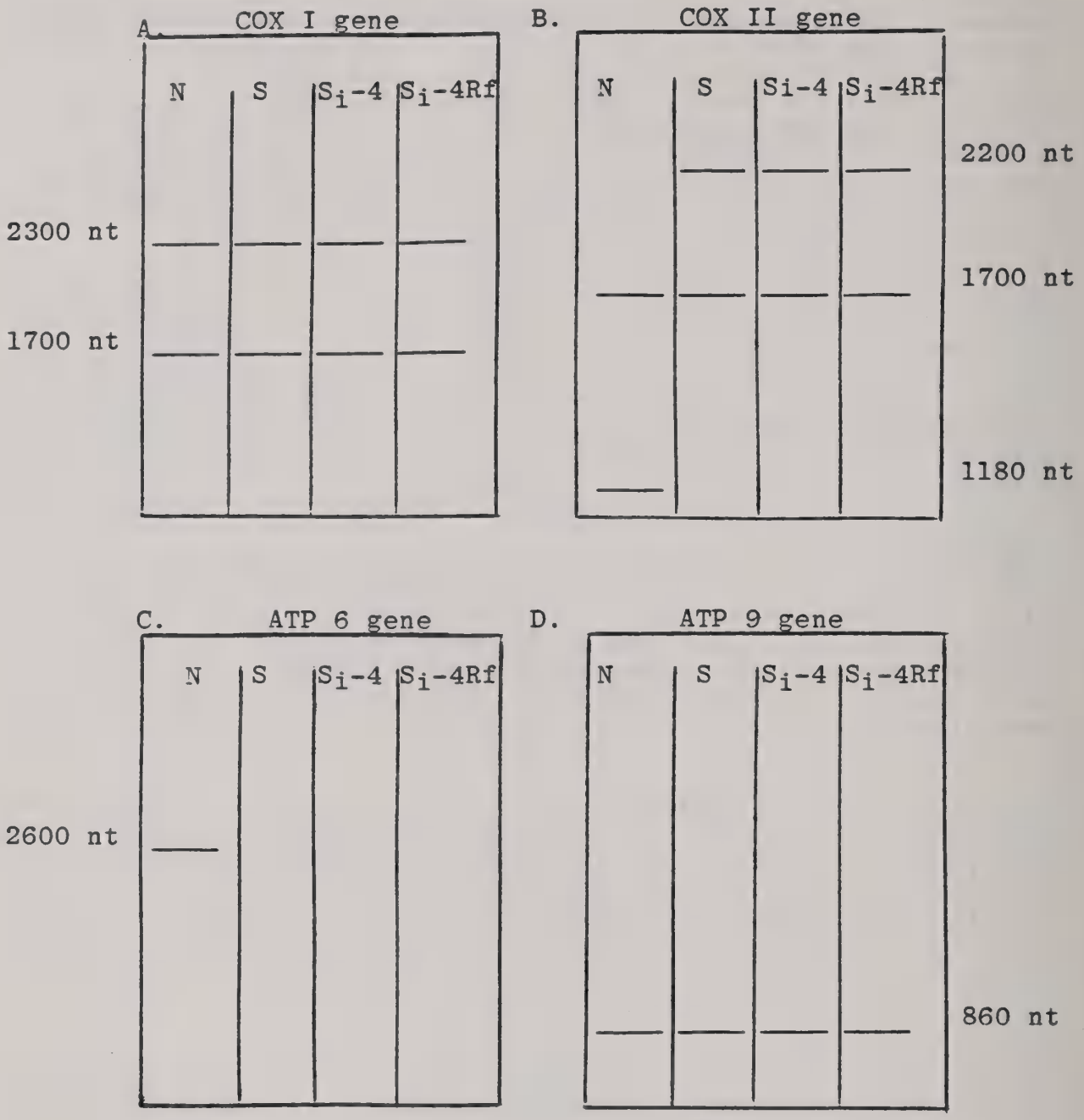

Figure 1. Schematic diagrams of the auto-radiographs of N, S, S_i-4, and S_i-4 Rf cytoplasms probed with radioactive maize mitochondrial encoded respiratory genes. Transcripts of mRNA for A = cytochrome oxidase unit I gene; B = Cytochrome oxidase unit II gene; C = ATPase complex subunit 6 gene; D = ATPase complex subunit 9 gene.

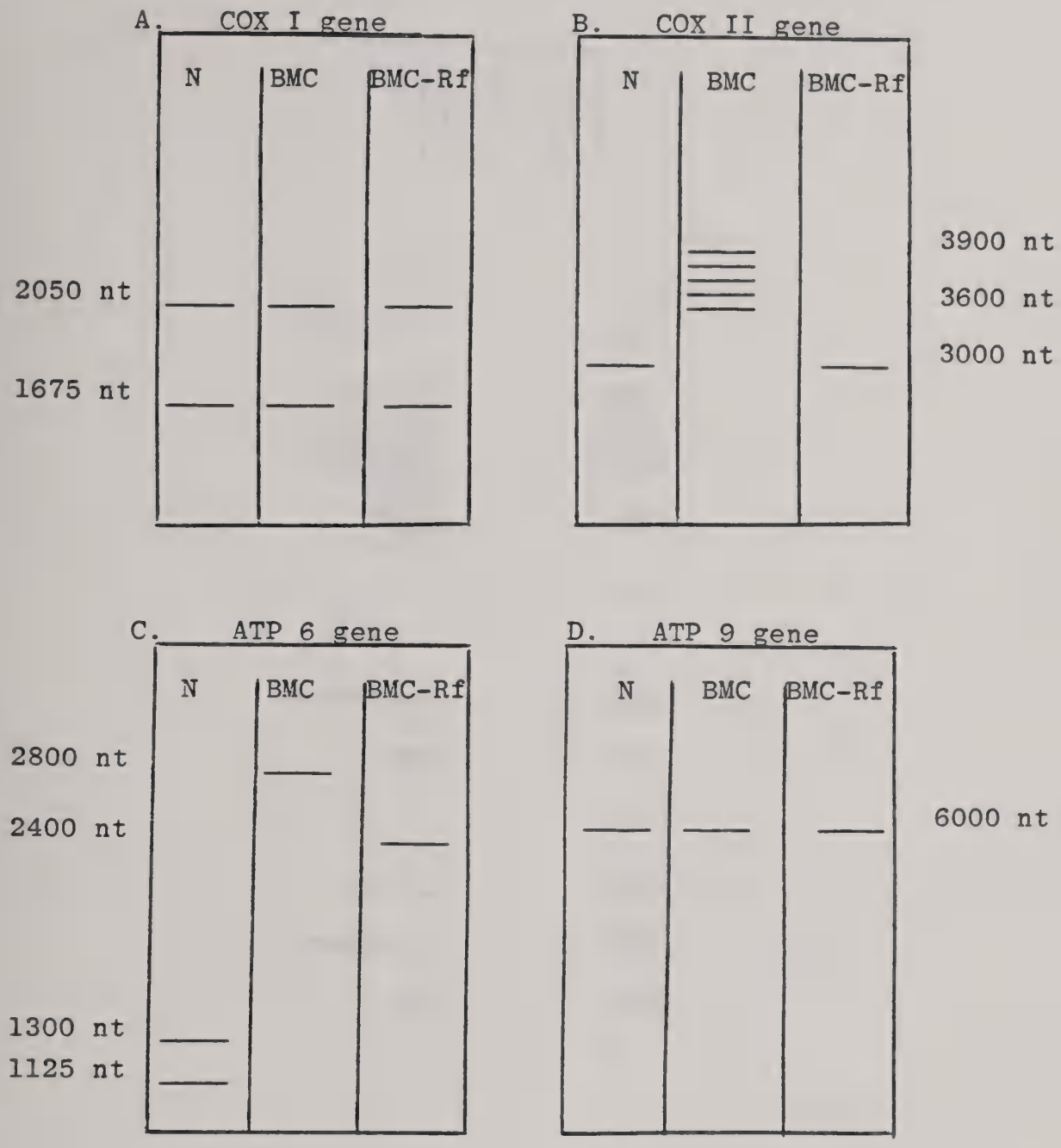

Figure 2. Schematic diagrams of the auto-radiographs of N, BMC, and BMC-Rf cytoplasms probed with radioactive maize mitochrondrial encoded respiratory genes. Transcripts of mRNA for A = Cytochrome oxidase subunit I gene; B = Cytochrome oxidase subunit II gene; C = ATPase complex subunit 6 gene; D = ATPase complex subunit 9 gene.

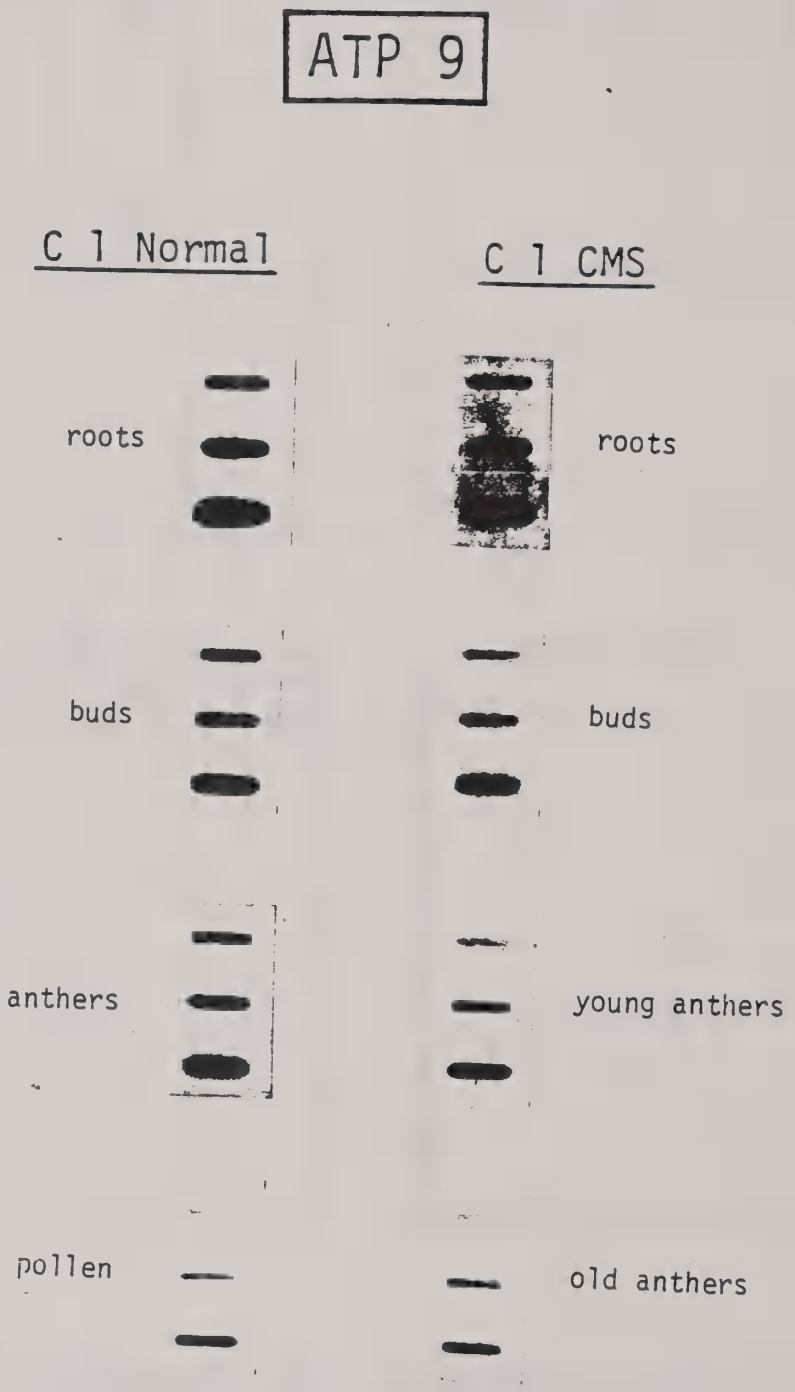

Figure 3. Autoradiographs of slot blots of mitochondrial nucleic acids isolated from roots, buds, anthers, and pollen of S-CMS and normal cytoplasms, hybridized with the maize ATP 9 mitochondrial gene. The three blots for each tissue from top to bottom were from 0.5, 1.0, and 5.0 µg of nucleic acid, respectively.

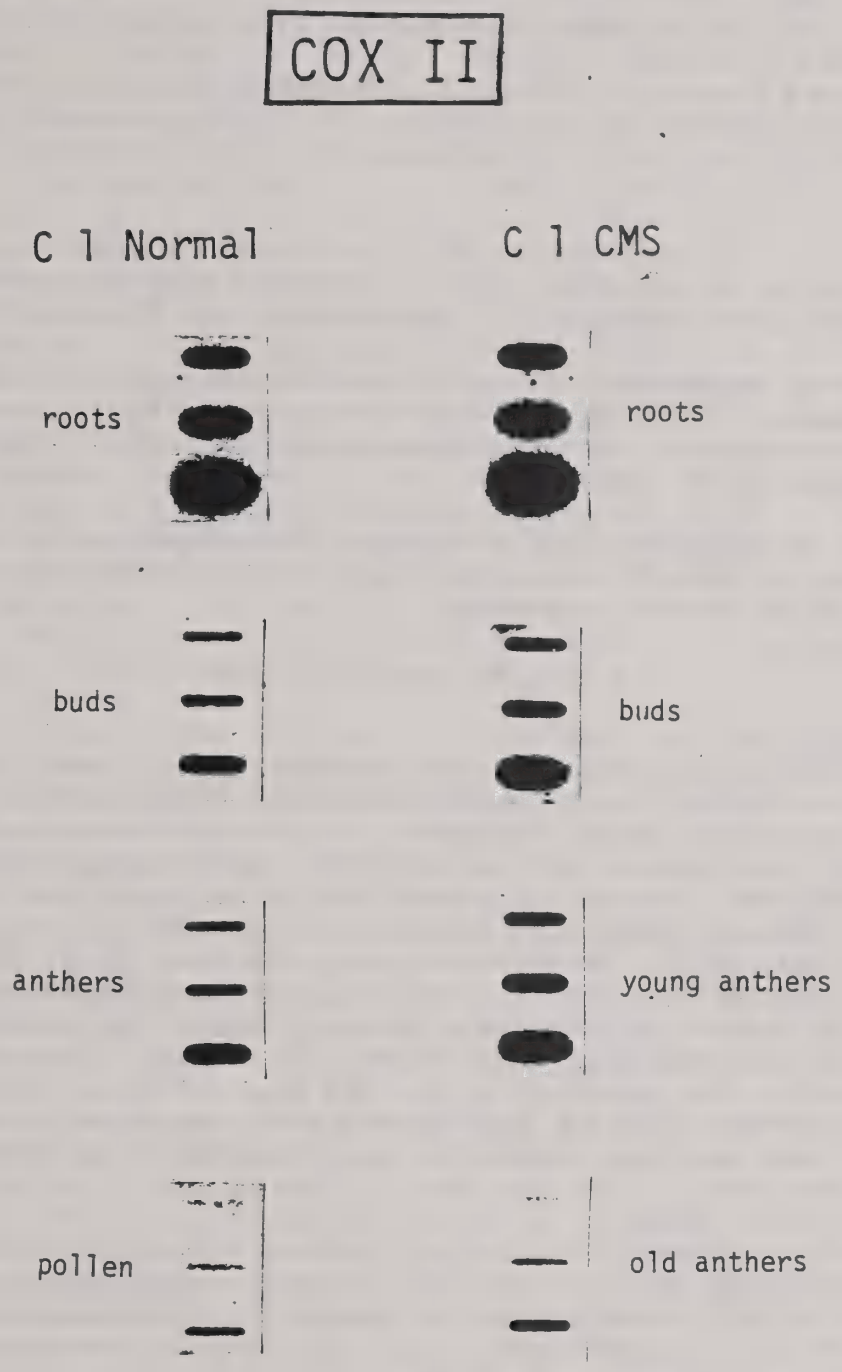

Figure 4. Autoradiographs of slot blots of mitochondrial nucleic acids isolated from roots, buds, anthers, and pollen of S-CMS and normal cytoplasms, hybridized with the maize COX II mitochondrial gene. The three blots for each tissue from top to bottom were from 0.5, 1.0, and 5.0 µg of nucleic acid, respectively.

SELECTION AND DEVELOPMENT OF SMOOTH SUGARBEET VARIETIES

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Two experiments were conducted in 1988 to evaluate the development of smooth root (SR) varieties of sugarbeet. Both experiments were conducted on the K. English farm at Breckenridge, Michigan, on Bixbiro fine sandy loam soil.

The objective of Experiment 8820 was to evaluate the agronomic performance of SR experimental hybrids and to compare them with smooth-root genotypes and standard commercial cultivars for smoothness of root and the quantity of soil harvested with the root.

The objective of Experiment 8821 was to evaluate the agronomic performance and smoothness of root of selected SR progenies and to make additional SR selections from these progenies.

Materials and Methods

Experiment 8820:

Three commercial cultivars, 3 smooth root lines, and 4 F_1 hybrids listed in Table 1 were included in the field trial. SR87, the pollinator of all of the F_1 hybrids, is our best smooth root line. The 10 entries were planted in 6 replications of a randomized block design. Individual plots consisted of 2 rows 28" (71 cm) apart and 30' (9 m) in length. The experiment was planted April 22, 1988 and was thinned to single plants 8-12" (20-30 cm) within the row on June 1-3, 1988. Harvest was made November 18, 1988, using an experimental mini-harvester with puller wheels and a series of rotating star rinks similar to those for a conventional sugarbeet harvester. Beets were bagged and transported to the laboratory at the B&B Research Farm. Soil was scraped from the roots, and both the cleaned roots and soil quantity was weighed. Each root was scored for smoothness on a 1 to 5 scale defined below:

1 = Very smooth taproot, no grooves, broad fibrous root zone
2 = Smooth, slightly grooved taproot, narrow fibrous root zone
3 = Partially smooth, grooved, heavy fibrous nonbranching taproot
4 = Rough shaped taproot, deep grooves, heavy fibrous roots with some sprangling
5 = Very rough, very deep grooved, multiple branched taproot

A sample of soil was collected and dried in an oven at 85°C for 72 hours to determine the moisture content of soil and convert soil measurement to a dry weight basis. A 10-beet sample was saved for brei and sucrose percentage and clear juice purity was determined on the pressed juice at the Michigan Sugar Company Research Lab at Carrollton, MI.

Experiment 8821:

Seventeen smooth root selections and 3 commercial varieties were included in this experiment. The study consisted of 4 replications of single row plots with rows 28" (71 cm) apart and 30' (9 m) in length. Planting and thinning were accomplished on the same dates as listed above for Experiment 8820. Harvest was made on December 5 (late harvest due to heavy rains and inaccessibility to field plots prior to this date) in a manner similar to that cited above for Experiment 8820.

Results

This year, the smoothly root experiments were hampered by the relatively dry spring, the hot, dry summer, and the wet fall. There was some stand loss due to an insufficient supply of water for seed germination and emergence. There was also a loss in stand in various areas in the field because of Rhizoctonia root rot. At harvest, a stand count was taken and an adjustment was made to correct stand losses in each plot. Harvest was delayed in the fall due to rain and flooded conditions on the field. The soil was relatively moist for harvest of Experiment 8820, but was so wet when we could get into the field to harvest Experiment 8821, that soil adhered to the smooth, non-grooved roots as much as to the standard cultivars. Thus, data on the quantity of soil harvested was not valid for Experiment 8821 and is not included in this report.

Table 1 lists the means for yield sucrose percentage, smoothness score, and soil harvested with roots for commercial hybrids, smooth root lines, and hybrids in Experiment 8820. RWSA and root weight of the hybrids were equal or superior to the check varieties. The hybrids were significantly lower in RWST and sucrose percentage. Hybrids were also significantly better in smoothness of root than the commercial cultivars. Soil harvested with the hybrids averaged 31% less than for commercials. SR87 was significantly the smoothest root entry, with 60% less soil harvested with the roots. This line had good root weight but it was low in sucrose percentage and RWST. It would appear that a hybrid with smooth root germplasm from both the female and male parental lines would give an excellent "soil-free" variety.

Agronomic performance for Experiment 8821 is shown in Table 2. All SR selections were significantly lower in smoothness score than the checks. Most of the selections showed 1-2% less sucrose percentage and were significantly lower in RWST than commercial hybrids. This data again substantiated conclusions of previous years that in general, our smooth root genotypes need to be improved in sucrose content before they can be used as inbred seed parents of hybrid varieties. One selection, 8580-5 (Entry 17), currently shows good potential as a breeding line and will be tested for combining ability and possible release to the sugarbeet industry. In 3 years' tests, this line had good root weight with an average of 94% of the RWST of MHE4. Two selections (7 and 13) had RWST equivalent to the check varieties and these also will be tested for combining ability with standard CMS lines.

Conclusions

1. Excellent progress is being made towards the development of smooth root hybrid sugarbeets.

2. Four experimental hybrids averaged 31% lower soil harvested with roots, and approximately equal RWSA.

3. Our best SR line had only 40% of the soil harvested on roots as did the commercial cultivars.

4. Most smooth root lines have equal or greater root weight than commercial hybrids, but they need improvement in sucrose content.

Table 1. Means for yield, sucrose, smoothness score, and soil harvested with roots for commercial cultivars, smooth root lines and hybrids. 1988 Experiment 8820.

LIST OF VARIABLES

VAR	TYPE	NAME/DESCRIPTION
1	numeric	VARIETY CODE NO.
2	text 10	VARIETY SEED NO.
3	numeric	RWSA
4	numeric	RWST
5	numeric	TONS/ACRE
6	numeric	SUCROSE %
7	numeric	CJP %
8	numeric	SMOOTHNESS AVERAGE SCORE
9	numeric	POUNDS SOIL PER 100 POUNDS ROOT WEIGHT
10	numeric	POUNDS SOIL PER TON OF BEETS HARVESTED

1	2	3	4	5	6	7	8	9	10
Commercial Cultivars									
1	MHE4	7609	298.6	25.5	17.80	93.94	3.39	34.9	697.6
2	ACH176	7207	290.7	24.8	17.31	94.07	3.25	25.2	504.9
3	USH23	6798	275.7	24.7	16.37	94.33	3.30	29.6	592.8
CMSxSR87 Hybrids*									
5	WC87016	7109	264.3	26.9	15.86	93.88	2.91	18.8	376.7
6	WC87017	6820	258.7	26.4	15.59	93.68	2.72	20.9	418.2
7	WC87018	6121	257.8	23.8	15.50	93.79	2.73	22.8	455.1
8	WC87019	7224	256.0	28.2	15.55	93.32	2.17	20.1	402.0
Smooth Root lines									
4	85700	6402	249.7	25.6	15.13	93.50	2.62	20.0	400.7
9	SR87	6682	243.1	27.5	14.86	93.11	2.24	12.0	240.8
10	85131-16	6309	263.9	23.9	16.09	93.02	2.39	26.2	524.1
	MEAN	6828	256.8	25.7	16.01	93.66	2.78	23.1	461.3
	LSD .05	681	13.3	2.4	0.62	0.78	0.24	5.7	114.1
	CV	9	4.3	8.2	3.35	0.72	7.59	21.3	22.2

*Hybrid description:

WC87016 = (SP6926/FC607) x SR87
WC87017 = EL36C2 x SR87
WC87018 = SP85576-01 x SR87
WC87019 = SP85657-01 x SR87

Table 2. Means for yield, sucrose, and root smoothness score for smooth root progenies. 1988 Experiment 8821.

LIST OF VARIABLES

VAR	TYPE	NAME/DESCRIPTION
1	numeric	VARIETY CODE NO.
2	text 10	VARIETY SEED NO.
3	numeric	RWSA
4	numeric	RWST
5	numeric	TONS/ACRE
6	numeric	SUCROSE %
7	numeric	CJP %
8	numeric	SMOOTHNESS AVERAGE SCORE

1	2	3	4	5	6	7	8
1	MHE4	8198	294.0	27.9	17.09	95.40	3.63
2	ACH176	7236	307.5	23.5	17.93	95.13	3.38
3	USH23	6985	289.7	24.1	16.74	95.76	3.39
4	87H1-3	5795	269.7	21.6	15.67	95.63	2.13
5	87H1-4	5792	273.2	21.1	15.98	95.21	2.66
6	87H1-5	6135	265.0	23.1	15.42	95.59	2.70
7	87H1-6	5596	290.1	19.3	16.63	96.23	2.52
8	87H1-7	6149	267.4	23.0	15.82	94.62	2.82
9	87H1-8	6396	264.1	24.2	15.50	95.14	2.36
10	87H1-10	6739	271.4	24.8	16.15	94.29	2.46
11	SP8562-8	5533	268.5	20.6	15.85	94.75	2.54
12	SP8549-11	7059	276.0	25.6	16.19	95.05	2.25
13	SP8549-18	5578	285.9	19.5	16.59	95.58	2.14
14	SP8549-25B	6995	271.0	25.8	16.01	94.69	2.05
15	SP8549-59	6073	263.2	23.1	15.42	95.24	2.15
16	SP8579-11	6090	268.2	22.7	15.74	95.10	2.67
17	SP8580-5	7987	277.0	28.9	16.22	95.14	2.72
18	SP85110-3	6641	262.4	25.3	15.35	95.33	2.04
19	SP85115-3	7051	274.2	25.8	16.09	95.02	2.20
20	SP85114-3	7003	267.7	26.1	15.73	95.01	2.34
	MEAN	6551	275.3	23.8	16.11	95.20	2.56
	LSD .05	1057	17.4	3.4	0.89	1.05	0.46
	CV	11	4.5	10.2	3.89	0.78	12.70

ROW SPACING AND PLANT DENSITY EFFECTS OF SMOOTH ROOT SUGARBEETS

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Smooth root sugarbeets have the advantage over present day varieties of ease of harvest, less wear on harvest machinery, less soil to transport, less bruising of the root, and better storageability in piles awaiting processing. We have developed breeding lines with relatively smooth, non-grooved taproots, and in a few years, we could be growing smooth-root cultivars. With the recent emphasis on narrow rows, in this growing area it is apparent that we need to know how smooth root types respond to density in closer row spacings.

This study was designed to compare the production of smooth root lines with that of adapted commercial varieties under different spatial arrangements in the field.

Materials and Methods

Two smooth root lines of sugarbeet (SR87 and 87H1-00) and 2 commercial cultivars (MHE4 and ACH176) were planted at the B&B Research Farm in 1988 in a split-plot randomized experiment of 6 replications on May 3, 1988. Individual plots were planted between tractor wheel tracks spaced 88" (2.24 m) apart. Three plant spacings were planned: (1) Conventional 28" (71 cm) row width with plants spaced 8" (20 cm) apart within the row: (2) Rows 20" (52 cm) apart with 8" (20 cm) within row plant spacing; and (3) Plants in rows 14" (35.2 cm) apart with a single beet every 14" (35.2 cm) within the row. Plant density for these spacings would be approximately 28,000, 39,200, and 32,300 plants/acre for the 28", 20", and 14" row spacings, respectively. Each individual plot was 30' (9 m) long. The 28" plots consisted of 3 rows, the 20" of 4 rows, and the 14" of 5 rows. The experiment was harvested on October 6-7 by hand-digging all of the roots in the center rows of each plot. The outside 2 rows of each plot served as borders and were not harvested Roots were weighed and a 10-beet sample was taken from each plot for sucrose and purity analysis.

The tops were removed from the roots, and roots and top fresh weights were determined. A 10-beet root sample was taken from each plot for sucrose and purity analyses. Three tops and a sample of root brei from each plot was dried in an 85^{o}C oven for 72 hours to determine the dry matter percentage and calculate the total dry matter produced by each variety in each spacing. Data was analyzed using the MSTAT statistical program.

Results

The experiment had an excellent stand immediately after seedling emergence. However, the lack of moisture, cracking of the soil, and the increased

incidence of Rhizoctonia root rot experienced during the summer of 1988 resulted in a stand at harvest which was less than that desired. Visually, it appeared that the more dense stands, i.e., the 14" and the 20", had greater Rhizoctonia root rotting. An estimate of the stand just prior to harvest was utilized to adjust the plot yield.

Variety means, row spacing means, and variety X row spacing interaction means are given in Table 1. The commercial varieties were significantly better than the smooth root entries for almost all factors. SR87, however, was significantly better than MHE4 and ACH176 in tons/acre and root/top dry weight ratio.

No significant differences were observed for the row spacing treatments, but there was a slight trend for the higher densities to have higher RWSA and tonnage. This lack of difference in row spacing may be due to the adverse dry seasonal effects or possibly to other cultural factors. Actual plant stand on the 28" row spacing determined by beet count at harvest averaged 10.8" between plants within the row, rather than the 8" desired. Within-row spacing for 20" rows was 9.5" and for 14" rows, was 15".

Only 4 of the variety X row spacing interactions showed significant differences. ACH176 in 14" rows had greater RWSA than in 28" rows, and greater tonnage/acre in 14" rows than in either 28" or 20" rows. The smooth root varieties (SR87 and 87H1-00) had significantly higher purity in the 14" row compared to the 28" row spacing.

This experiment will be repeated in 1989 and possibly in 1990.

Table 1. Means of row spacing and plant density trial with two smooth root lines and two commercial cultivars. 1988 Experiment 889.

LIST OF VARIABLES

VAR	TYPE		NAME/DESCRIPTION
1	text	8	VARIETY
2	text	4	ROW SPACING
3	numeric		RWSA
4	numeric		RWST
5	numeric		TONS/ACRE
6	numeric		SUCROSE %
7	numeric		CJP%
11	numeric		R/T RATIO DRY WT.
12	numeric		DRY WT. TOPS lbs.
13	numeric		DRY WT. ROOTS lbs.

		1	2	3	4	5	6	7	11	12	13
Variety Means											
MHE4		6348	296.1	21.5	17.73	93.75	3.27	7.43	23.49		
ACH176		6370	311.2	20.5	18.47	94.12	3.17	7.57	22.99		
SR87		5923	251.0	23.6	15.39	92.86	3.73	6.07	21.58		
87H1-00		5903	264.0	22.4	15.88	93.77	3.44	6.55	21.41		
LSD .05		335	7.2	1.2	0.35	0.39	0.25	0.41	1.31		
Row Spacing Means											
	28"	6050	278.0	21.9	16.81	93.33	4.26	6.87	22.10		
	20"	6122	283.8	21.7	17.01	93.74	3.13	6.64	22.29		
	14"	6236	280.0	22.4	16.78	93.81	2.81	7.21	22.72		
LSD .05		466	11.8	1.8	0.57	0.50	0.30	0.60	1.77		
Variety x Row Spacing Means											
MHE4	28"	6252	294.1	21.3	17.63	93.71	4.08	7.45	23.10		
MHE4	20"	6426	300.2	21.4	17.91	93.91	2.92	7.49	23.74		
MHE4	14"	6368	294.1	21.7	17.65	93.62	2.82	7.36	23.63		
ACH176	28"	6017	309.3	19.4	18.47	93.78	4.06	7.11	21.81		
ACH176	20"	6269	316.8	19.8	18.66	94.50	2.85	7.19	22.21		
ACH176	14"	6825	307.7	22.3	18.28	94.07	2.60	8.41	24.95		
SR87	28"	6011	244.8	24.5	15.18	92.36	4.69	6.16	21.95		
SR87	20"	5757	253.1	22.7	15.48	92.96	3.46	5.73	21.29		
SR87	14"	6002	255.3	23.6	15.52	93.26	3.02	6.33	21.51		
87H1-00	28"	5922	263.8	22.5	15.96	93.45	4.23	6.77	21.53		
87H1-00	20"	6036	265.3	22.7	16.01	93.58	3.29	6.15	21.91		
87H1-00	14"	5751	263.0	22.0	15.66	94.28	2.80	6.72	20.79		
MEAN		6136	280.6	22.0	16.88	93.62	3.40	6.91	22.37		
LSD .05		581	12.5	2.0	0.60	0.68	0.44	0.71	2.28		
CV		8	3.8	8.0	3.09	0.63	11.2	8.87	8.77		